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AMERICAN ANTIQUITY

VOLUME 25 APRIL 1960 NUMBER 4

EDITORIAL

The first issue of this journal appeared 25 years ago under the editorial guidance of W. C. McKern. In his early editorials McKern set forth with vision and clarity the goals and purposes of the newly-formed Society for American Archaeology. He returns to these pages by invitation to offer his observations of the Society's efforts to achieve these aims during . . .

THE FIRST QUARTER CENTURY

A HISTORICAL SUMMARY of the first 25 years of the Society for American Archaeology has, in my opinion, little purpose other than that it may serve as a measuring device by means of which to determine to what extent the original objectives of the organization have endured as important goals, and what progress has been made towards their achievement. The procedure here will be to present the factors motivative towards and productive of organization, selected highlights in the story of the Society's development, noteworthy accomplishments with consideration given to how they were accomplished, and the present status in comparison with original purposes. Complete lists of officers and committees, with dates of incumbency and other details, are space-consuming items that can easily be located in the reports of annual meetings published in AMERICAN ANTIQUITY, and will not be found here excepting in instances where they have a specific bearing on related events.

The original objectives of the Society were inherent in the problems and manifest needs that resulted in the birth of the organization. The recognition and formulating of these needs, however, with the suggestion of organization as a solution, came from two independent sources. The Committee on State Archaeological Surveys, created in 1921 by the National Research Council to stimulate greater interest and coordination of efforts among American archaeologists, had become increasingly aware of a lack of cooperation — in fact, basic misunderstanding — between professional archaeologists and non-professional workers with interests actively centering about archaeology or archaeological materials in various ways. It became the consensus within the Committee that archaeology could profit from the experience of such sciences as ornithology and astronomy in organizing the interests of laymen towards securing a broader web of information. At a meeting in 1933 the Committee endorsed the idea of a national organization to include both professional and non-professional members.

The following spring, at an anthropological convention in Columbus, Ohio, a group of archaeologically minded attendants were engaged in a "bull session" one evening — and accuracy compels me to add: in a smoke-filled room. P. F. Titterington, a St. Louis roentgenotherapeutist with amateur interests in archaeology, proposed the immediate founding of an organization including in its membership both professional and non-professional students of American archaeology. He supported his proposal with the argument that the amateur would profit from the training and experience of the professional personnel, and that the latter would benefit from the wider observance of the many with amateur interests. Such an association would tend to correct the errors of non-professional collectors and observers, and so render their productive efforts constructively useful rather than destructively harmful. Carl Guthe then reported the favorable reaction to such an organization by the Committee on State Archaeological Surveys, and others present joined in supporting the idea.

Following discussion, the group assumed the jurisdiction of a committee, with Fay-Cooper Cole acting as chairman. Guthe was authorized to circulate a letter of particulars and question-

naire to prospective members, and a committee to frame a constitution was appointed, consisting of A. V. Kidder (chairman), A. L. Kroeber, and Frank H. H. Roberts, Jr.

The response to the circular letter was favorable, and the organization meeting of the Society for American Archaeology was held on December 28, 1934, at the Hotel Roosevelt, Pittsburgh, Pennsylvania, following the annual subscription dinner of Section H, American Association for the Advancement of Science. Carl Guthe called the meeting to order. The committee's report on constitution and by-laws was received and adopted as revised. Thirty-one charter members signed the constitution. The following officers were elected: President, Arthur C. Parker; Vice-President, M. R. Harrington; Secretary-Treasurer, Carl E. Guthe; and Editor, W. C. McKern. Members elected to the first Council in addition to the officers were: E. F. Greenman, Emil W. Haury, Diamond Jenness, F. H. H. Roberts, Jr., Leslie Spier, W. D. Strong, George C. Vaillant, and William S. Webb. The Editor was authorized by the Council to proceed with the first issue of a quarterly organ of the Society, to be titled, AMERICAN ANTIQUITY, as soon as funds and material for publishing should become available.

It should be noted that the adventurous launching of this new organization, new in concept as well as in time, came in the middle of the great depression of the thirties. Money was never scarcer. Career students of anthropology, upon completion of their university training, were glad to accept low-pay positions such as helpers in museums or supervisional assistants on TVA and other reclamation projects. The new Editor faced the necessity of getting AMERICAN ANTIQUITY — the voice of the Society — out to the members at the earliest possible date. The growth, the continued existence of the Society, depended upon the success of its publication. But there was no publishable material at hand, and publication funds could not be provided until the gradual accumulation of dues adequately equipped an initially flat treasury.

In this emergency, Paul Titterington came to the rescue. He had prepared a well illustrated article on "Certain Bluff Mounds of Western Jersey County, Illinois," and he proposed that this, with such other material as could be collected and edited within a month, should make up the first number of the journal, the publication funds to be provided by Titterington. The Committee on State Archaeological Surveys contributed Part 1 of its 1934 report on archaeological field work in North America, and these two items, with messages from the officers and four book reviews, permitted a first number of AMERICAN ANTIQUITY to be released in July, 1935, seven months after the organization meeting. By this time there remained no doubt that material and funds for the second number would be available.

The objectives of the Society were clearly expressed by its first officers. President Parker's message in the first number of AMERICAN ANTIQUITY cited the need for standardizations of purpose and methods acceptable to all students of American archaeology, and added: "Through the publication of AMERICAN ANTIQUITY it is hoped that literature may be provided for a more uniform nomenclature, for culture classification and for the common facts and methods needful for concerted action."

Secretary-Treasurer Guthe, noting in his message the upturn in archaeological interest occasioned by the Tennessee Valley and other salvage programs, concluded: "We feel that American Indian archaeology has many friends, and we are anxious to become acquainted with them. At the suggestion of one of them, the idea of a national Society for American Archaeology came into being. Its purpose is to make it possible for everyone, professional and nonprofessional alike, to become acquainted with the story in which all are interested. The Society has been so organized that the office of the Secretary-Treasurer may serve . . . as a means by which members of the Society may be kept in touch with activities and brought into contact with the men and the problems with which they are most concerned."

The Editor, in his message, expressed the hope that AMERICAN ANTIQUITY would ". . . become an instrument of value in coordinating the research efforts of all sincere students of American archaeology." Later, in his report at the first annual meeting of the Society (1935), he made the following policy statement: "The journal of any scientific society should have as a basic purpose the bringing of the geographically scattered members into a close circle of common interests and aims through serving as a ready channel for the dissemination of information and the exchange of ideas. This purpose is of increased importance in a society having both specialist and amateur members, . . . and

which proposes to establish a sympathetic understanding and mutually helpful cooperation between these two groups. If the Society and its journal are to succeed, the policy of the Editor must be that of serving the best interests of both the specialist and the amateur; which is but another way of saying, the best interests of American archaeology."

Thus conceived and created by a group of archaeologically interested students, including both those with vocational and those with avocational approaches to the field, and founded on the principle of mutual interests and benefits, the new Society got under way with the initial support about equally divided between the two elements in its dichotomy. In the 1935 total membership (442), the non-professional members held a slight majority over the professionals.

In addition to financing and improving its quarterly, the earliest efforts of the Society were directed towards standardizing archaeological terminology. For several years committees were appointed, and their various reports received and discussed at the annual meetings. These committees produced many valuable suggestions and fertile ideas. Actually, however, although the efforts of the committees frequently pointed out the way, the closer contacts and exchanges of data and methods provided for by the new organization did more to improve and standardize terminology than did the detailed recommendations of any committee. Such tools have a way of developing as the work broadens and progresses.

The first five years of the Society were years of basic establishment and initial experience, accompanied by growing pains and financial tightness. Archaeologists might be disposed to call this the "formative period." The growth had been continuous and encouraging. At the end of the first fiscal year the membership was 344, including 16 institutional members. By the end of the fourth year there were 783 members. The journal grew much more slowly. There were 340 pages in the first volume, and 392 in the fourth. However, the quantity of material submitted and the quality of the articles printed had improved steadily. Financially, the Society was successful year after year in meeting its growing budget demands. This initial success during years of national crisis was due in no small measure to the wise guidance and indefatigable efforts of Carl Guthe, who served as Secretary-Treasurer during these five formative years. None of the early officers was neglecting his duties and responsibilities, but Guthe's constant attention to the young Society's needs far exceeded the call of duty.

The *Notebook*, intended to provide detailed presentations of those methods, equipments, and other technological aids that might prove of value to professionals and non-professionals alike, authorized in the original constitution, did not materialize until 1939. Its introduction aroused a considerable froth of interest. There were six issues in 1940, but only two the following year, for which a dearth of submitted copy was responsible. We hear Editor Douglas Byers complaining that, whereas the *Notebook* seemed to be popular, its Editor, Frederick Johnson, could only publish such material as was submitted; and later announcing that the publication would come out "irregularly as the quantity of material warrants." Almost immediately thereafter the *Notebook* expired, quietly but permanently.

The original constitution had served as a platform of fundamentals upon which the Society could take its original stand and grow. It successfully served that purpose, but by 1941 it had become inadequate to meet the requirements of the complexly expanding organization. A committee to revise the constitution worked under the chairmanship of J. Alden Mason, and a new constitution was adopted in 1942. It clarified financial procedures; defined more specifically the duties and responsibilities of officers; authorized committees; established and fixed the duties of the Executive Committee; added one Vice-President, a Treasurer, and an Associate Editor to the official staff; eliminated the controversial membership category of "Fellow," while adding three classes of special members; and in other ways modernized the instrument to meet new conditions.

A period of improvement and enlargement of AMERICAN ANTIQUITY had started when Douglas S. Byers took over the Editorship in 1939. At the time he took office there was on hand a backlog of material awaiting publication that promised a delay of as much as two years in printing, but some papers had timely significance that would make them out-of-date by the time they finally appeared in the journal. Byers sought ways to increase the capacity of the magazine, and to publish occasional contributions outside the covers of AMERICAN ANTIQ-

UITY. The first *Memoir* came out in 1942, to start a continuous series of valuable contributions published in this category.

In 1945 the Editor's recommendation to change the format of the journal was accepted and, as a result, 75 more words could be printed on each page, or one more article on the average in each issue. This was accomplished by changing the format to a two-column page, by increasing the page size to the maximum that can be handled at minimum cost by the press, and by making a slight alteration in the type style.

As the Society grew, the non-professional members had maintained a majority status, as reported by the Editor in 1945. The problem of serving the best interests of all in the membership had become increasingly acute, since a large percentage of those contributing material to the journal were in the professional ranks of the membership. Reacting to complaints by some of the non-professional members that many of the articles on subjects of wide general interest made use of such highly technical terminology that they were understandable only to specialized students, Byers made an eloquent plea to professional contributors to express themselves, whenever possible, in language that all could understand. Of course, there would always be a type of article, important to good subject presentation and the archaeological prestige of the journal, that would require use of the most technical of terms.

During World War II, when many anthropologists were in the service, a scarcity of material for publication developed. The *American Anthropologist*, having difficulty in getting enough publishable material to maintain a journal of normal size, proposed that AMERICAN ANTIQUITY, which was experiencing less difficulty in this matter, restrict its subject matter to factual articles, and that archaeological contributions to theory be published in the *American Anthropologist*. Such a restriction, however, was deemed so unfair to members of the Society for American Archaeology that the suggestion was not accepted.

The new Editor assuming office in 1947, Irving Rouse, was confronted almost immediately with a rise in printing costs. He met the problem by restricting the scope of articles accepted, limiting the length of contributions, and raising standards of quality. It is noteworthy that, throughout its history, the Society has given its Editors a rather free hand in policy matters, retaining its control of its publication primarily by holding the purse strings. True, all major issues were passed on by the Executive Committee, but there is on record no instance of a major request made by an Editor in the field of policy that was not granted. This attitude on the part of the Executive Committee and the membership, placing, as it did, primary responsibility for the direction of the journal on the shoulders of the Editor, and giving him a reasonably free hand to operate, has resulted in a continuously progressive magazine at all times alert to the possibilities for enlarging and improving its scope and value in the field of anthropological literature.

With the conclusion of World War II, the Society set about to enlarge and broaden its activities. The membership had increased to 927 by 1949. An optimistic sense of peace and prosperity prevailed, and the membership dues were raised from the original three to six dollars without a material loss of members. Material for publication again became plentiful. The Society widened its field of influence and prestige. It was selected as the agency to confer the Viking Medal and Award annually on deserving candidates in the category of American archaeology. The first to receive the award wa A. V. Kidder. Due to certain ambiguities anc conflicts in the constitution, particularly in re gard to the duties and powers of the Executiv Committee, the Council, and certain officers, it received a third working over. This had bee a period of rehabilitation and preparation fc higher accomplishment. On retiring from the Editorship, Rouse reported an increase of 21% in the size of AMERICAN ANTIQUITY during the preceding four years.

Upon assuming office, the next Editor, Jesse D. Jennings, had immediately to find a new printer, as the George Banta Publishing Company, that had printed the journal from its inception, found it impossible to continue after July, 1950. Jennings persuaded the University of Utah Press to take over, an arrangement that has proven most satisfactory.

In 1954 the Society accepted affiliation with the American Association for the Advancement of Science. The expanding influence of the Society during the years immediately following was demonstrated by the receipt of funds in sponsorship of seminars, for archaeological salvage operations at both river-valley and high-

way construction sites, and for publications — the latter generously financed by foundations, councils, and commercial establishments. By 1957 the total membership had increased to 1388, and the 1956 volume of AMERICAN ANTIQUITY boasted an all-time record of 460 pages.

The quality of the journal, at that time under the Editorship of Richard B. Woodbury, had been steadily improving throughout the period of its existence, and particularly during the preceding 15 years; and this without any appreciable decrease in contributions accepted from non-professional writers. At the 1957 annual meeting, Editor Woodbury reported the following statistics on authorship: During the preceding three years, 68 published articles (79% of those offered for publication) had been by professional authors, and 11 published articles (74% of those offered for publication) had been by non-professional authors; 113 contributions to Facts and Comments (73% of those submitted) were by professionals, and 28 (61% of those submitted) were by non-professionals. The latter had authored 14% of the major articles and 21% of Facts and Comments. That these percentages were not larger was due to the understandable fact that non-professional members had offered far fewer subjects for publication than had professionals, as demonstrated by the acceptance percentages.

The Society continues to grow, and if we may draw conclusions from statistics, continues to serve at least the minimum requirements of its non-professional members. The last available membership figure is 1468, including 346 institutional members, and the non-professionals still hold a small majority. According to new-member statistics covering the last ten years, there were 405 new professional members during that period (including all members employed or with student status in anthropology, at any level), and 488 new non-professional members (including all individuals who list a non-anthropological occupation). During each of the last four of these years the number of non-professional new members has always exceeded that of the new professional members, with the exception of 1959 when they were even at 41. The trend represented by these figures has been a continuous one during the 25 years of the Society's existence. The last numbers of AMERICAN ANTIQUITY not only reflect the progressive efforts of the new Editor, Raymond H. Thompson, but serve as rather conclusive evidence that the journal continues to improve both in quality and size.

That the professional archaeologist is being served, and served well, is reflected in the growing membership and the recognition that the Society and its publications have received in anthropological and related scientific circles.

However, the picture is not one of storms receding over the horizon and prospects of all smooth sailing ahead. We have on hand unsolved problems, and there will be others developing in the years ahead. One problem that remains with us always is that of turning in a good performance for both categories of our membership, and one of our officers has listed this as the major problem of the Society. In the past, although there have been moments of dissension, peace has been maintained and a cordial spirit of cooperation now prevails. The success of the Society during its initial 25 years certainly stands as irrefutable evidence in support of the concept that created it.

W. C. MCKERN

HISTORICAL IMPLICATIONS OF A PATTERN OF DATES AT PIEDRAS NEGRAS, GUATEMALA

TATIANA PROSKOURIAKOFF

ABSTRACT

Inscriptions at Piedras Negras are shown to form a pattern of discrete sets of records, each inscribed on a group of consecutive monuments beginning with a stela depicting the "ascension motif." The earliest date in a series, identified by the upended frog glyph and called an "initial date" precedes the first dedicatory date by a number of years, falling within the span of an earlier series. A date in the first dedicatory hotun of each set is marked by a "toothache glyph" and is called the "inaugural date." The intervals between these dates are such that no single series exceeds the span of a reasonable lifetime, and it is suggested that the initial date represents something in the nature of a birth or name day of a ruler who accedes to power on the inaugural date, and that each set of monuments records the history of a reign. The representations on monuments are interpreted as portraits of rulers and their families. Initial and inaugural dates at other sites are identified by their respective glyphs, but no articulated series of reigns has been found outside of Piedras Negras.

The variations of the upended frog and toothache glyphs suggest that they are essentially verbal action glyphs. Other action glyphs are correlated with motifs on Yaxchilán lintels, where they follow close upon date notations. Groups of glyphs following the action glyph are identified as appellatives, and are found to contain feminine head prefixes when they refer to robed or skirted figures of women. It is suggested that "ben-ich" katun notations occurring with appellatives of rulers are to be counted from their initial dates. Lunar and determinant meanings ascribed to dates are shown to have no relation to action glyphs accompanying them, and the historical approach is recommended as being more consistent with observed glyphic patterns.

EVER SINCE TEEPLE (1931) first demonstrated the character of the lunar count in the supplementary series of Maya inscriptions, attempts have been made to find further astronomical significance in monumental texts. Perhaps the most amibitious was the work of H. Ludendorff (1930–43), who calculated astronomical configurations for a large series of Maya dates using the Spinden correlation. Both he and Spinden seemed convinced that the recorded dates were chosen specifically because of such configurations, but they failed to identify any hieroglyphs that consistently accompanied events of a given sort, and by and large, their thesis was rejected by contemporary scholars.

Two other propositions associating dates with calendrical significance have received wider acceptance. They too, however, fail to account adequately for the choice of the dates inscribed. Teeple's theory of determinants holds that some dates represent corrections of the solar year or are solar year anniversaries of the base of the long count, but in most cases the dates in question are not uniquely determined by the correction. For discussions of the problem, the reader is referred to Thompson (1950: 317–20), who has been the chief proponent of the theory, and to Satterthwaite (1947: 135–42), who has been its strongest critic.

The second proposition concerns a period of 819 days, which appears as a common factor in five distances between dates identified by distinctive glyphic passages (Thompson 1950: 212–7). No astronomical significance could be found for this number, and its function as a ritual cycle is not fully understood.

In spite of the meagerness of these results and their failure to account for the pattern of date sequences, the hypothesis that Maya dates were chosen exclusively for their astronomical and calendrical significance still prevails, and the alternative, that they were essentially historical records, is expressly rejected by Thompson (1950: 64), and consistently ignored by others. To the argument that astronomical records would inevitably result in frequent repetitions of the same dates at various sites, Thompson replies in effect that the import of the dates was prophetic and that combinations of factors related to auguries were so numerous that the potential choice of dates was very large. Even if true, this argument is hardly sufficient reason to reject categorically the possibility of historical content in Maya texts.

It is hardly to be expected that the historical nature of dates can be demonstrated or disallowed until the hieroglyphic texts are at least in part deciphered, for history does not run in regular cycles. Its characteristic patterns are complex and variable, and the same event can be formulated in a variety of statements. Nevertheless, there remains much that can and that needs to be said for the historical hypothesis, and in this paper I attempt to show that a cer-

tain pattern in the recorded events at Piedras Negras has the qualities one might expect of a historical narrative. Its general nature is that of overlapping but discrete series of dates, having a fixed order but variable intervals, and capable of being construed as expressing life histories of individuals (Fig. 1). This pattern is reflected in certain motifs depicted on the monuments, and in their physical grouping. Although in its entirety it seems to be peculiar to Piedras Negras, certain features of it can be detected also at Naranjo, though here the uncertainty of the deciphered dates and the poor photographic record of the inscriptions preclude an adequate reconstruction of the sequences.

PIEDRAS NEGRAS

At this site (Maler 1901), the first monument of a group dealing with a series of related dates is usually carved with a distinctive motif. In its characteristic form, this motif presents a person in ceremonial garb, seated on a cushion within an elevated niche or doorway reached by a ladder marked with footprints. I will call this the "ascension motif" (Fig. 3). The niche is framed by a "sky band" of astronomical signs, with a grotesque bird above, and a two-headed monster below, a combination of symbolic figures that I will refer to as the "cosmic motif." In some cases where an ascension is depicted, there is a robed figure standing on the ground in front of the niche, and in at least one case, human sacrifice is symbolically indicated.

The monuments dealing with a given series of dates are normally aligned in a group, their terminal dates recording an uninterrupted series of consecutive hotuns beginning with that of the ascension stela. Within the hotun recorded on this stela is given a date followed by a specific hieroglyph identified by a vertical band or ribbon tied in a knot at the top as if binding the central element (Fig. 2, 1st column). The bound element varies in different inscriptions, and since it is sometimes the head of an animate creature, J. E. S. Thompson, in informal discourse, has dubbed this form the "toothache glyph," a name which I will retain in order to avoid confusion of the glyph with other bundle forms. There is only one date in each series associated with this glyph, and since this date stands near or at the beginning of the record of current events for the series, it will be called the "inaugural date." Such a date is often repeated or celebrated by the record of its tun-count anniversaries. References to it cease when another ascension stela is erected and a new inaugural date takes its place. The only exception is the record on Lintel 3, where a katun anniversary of an inaugural date is inscribed after at least one later series had run its course.

Another class of dates is identified by association with the upended frog glyph heading the right column of phrases in Figure 2. Thompson (1931: 69) imputed to this glyph a lunar significance since a very similar glyph occurs in a lunar series as Glyph D, but he was unable to determine its meaning precisely. Since dates associated with this glyph are normally the earliest of a series and precede the inaugural date by a number of years, they will be called "initial dates." When a series contains more than one initial date, the later initial dates apparently refer to subsidiary figures and, so far as we know, are the earliest references to them.

The suggested terms are not intended to reflect the supposed meaning of the dates recorded or of the motifs, but are used to facilitate reference and to make more immediately apparent the regularities in the grouping and in the records of the stelae. Some personal judgment has been unavoidable in presenting the monumental series, but as far as possible, speculations concerning the significance of the pattern are relegated to a separate section, in which a specific interpretation is suggested. A graphic summary of the pattern is given in Figure 1.

Positions of hieroglyphs in texts are given by the system used by Morley (1937–38) and the following abbreviations are used to designate monuments and dates: St., Stela; L., Lintel; Alt., Altar; Str., Structure; IS, Initial Series date; CR, Calendar-round date; PE, Period ending date (used also for expressed anniversaries).

Series 1

Monuments. St. 25 — 9.8.15.0.0; St. 26 — 9.9.15.0.0.

Location. On platform in front of Str. R-9.

Initial motif. Ascension, with cosmic motif. No minor figure.

Initial date. Unidentified; apparently not recorded on ascension stela.

Inaugural date. 9.8.10.6.16 10 Cib 9 Mac — St. 25, IS with toothache glyph at A15.

The grouping of monuments at Piedras Negras, though exceptionally clear, does not include the earliest monuments, which are too eroded and too scattered to provide requisite

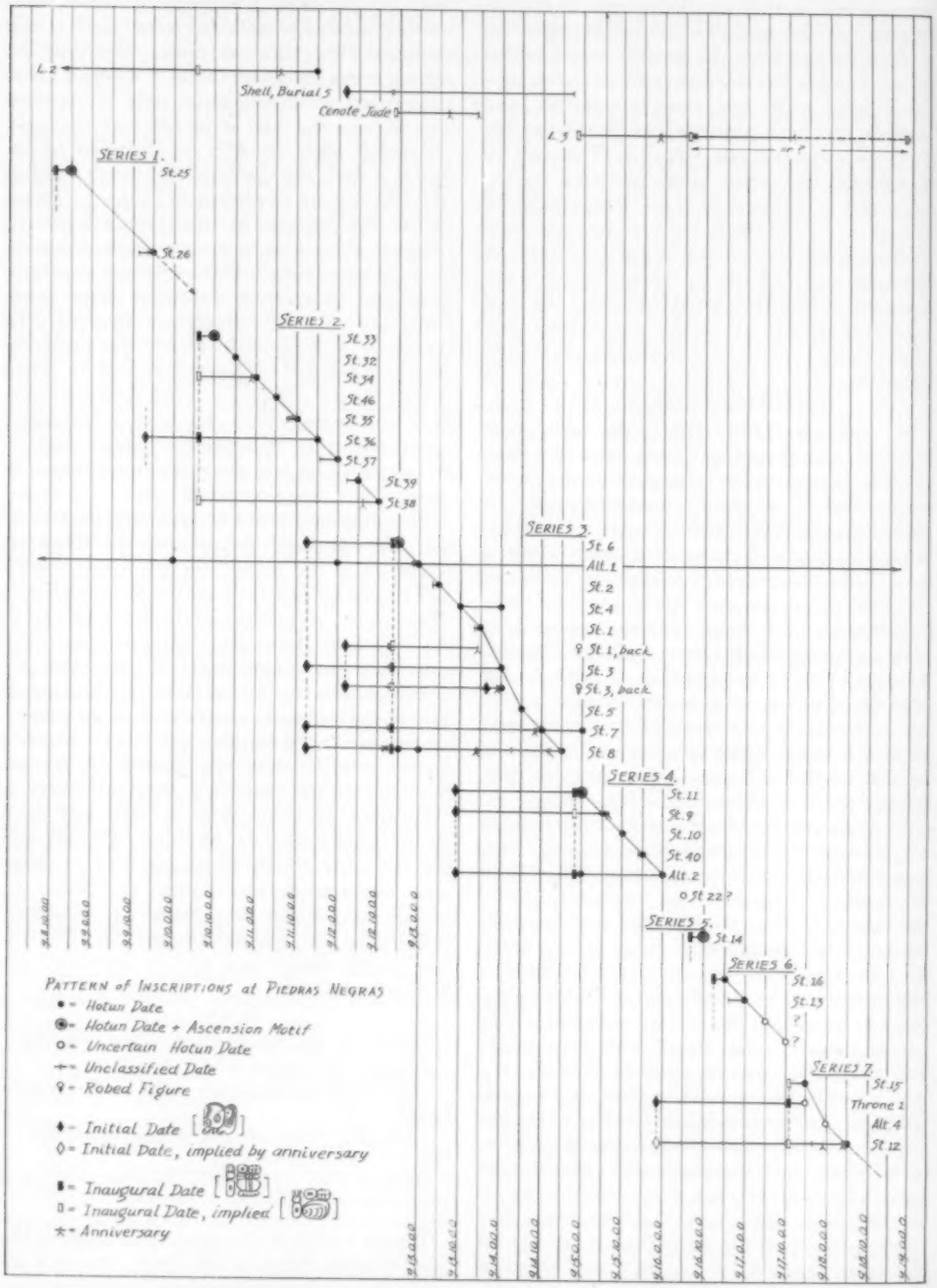

Fig. 1. Graph of inscriptions on monuments at Piedras Negras.

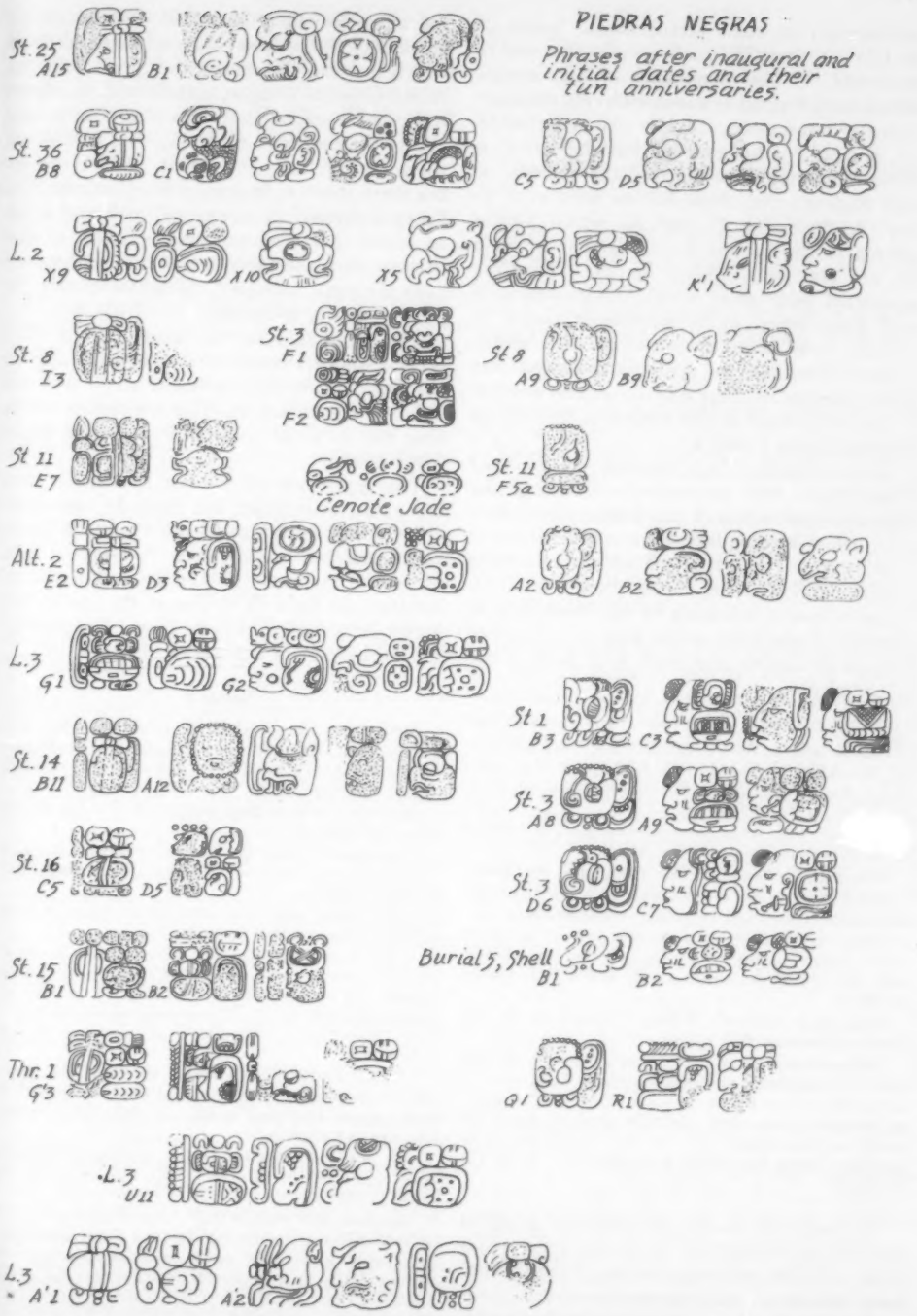

FIG. 2. Glyphic expressions following inaugural and initial dates and their anniversaries at Piedras Negras.

information on their arrangement. Stelae 25 and 26 constitute the earliest series that can be discerned. Unlike monuments of later groups, which were erected at hotun intervals, these are dated a katun apart. Morley places Stelae 28, 24, and 27 in the interval, but the dates on these monuments are illegible and there is no real evidence that these hotuns were ever recorded. Stelae 41, 43, and 31, which Morley assigns to the hotuns following that of Stela 26, are also very dubious in date. They are associated with other South Group structures and there seems to be insufficient reason to include them with the Structure R–9 group. Nevertheless, the first series as described may be incomplete, or there may have been another series, not covered in this summary, intervening between Series 1 and 2.

The toothache glyph appears on Stela 25 three times: first immediately following the supplementary series of the Initial Series date, then before a secondary series counted from it into the past (at I8), and finally after a series leading from it to the current hotun (at I12). In each case a reference to the same date is implied. There is an earlier date recorded, but judging by glyphs associated with it, it is not an initial date.

Series 2

Monuments. St. 33 — 9.10.10.0.0; St. 32 — 9.10.15.0.0; St. 34 — 9.11.0.0.0; St. 46 — 9.11.5.0.0(?); St. 35 — 9.11.10.0.0; St. 36 — 9.11.15.0.0; St. 37 — 9.12.0.0.0; St. 39 — 9.12.5.0.0; St. 38 — 9.12.10.0.0.

Location. First seven monuments aligned in front of Str. R–5; last two, in front of Str. K–5.

Associated sculptures. Lintel 2, found at Str. O–13; Lintels 4 and 5, at Str. R–5; Lintel 7, at Str. K–5(?). Possibly also Throne 2 and Miscellaneous Sculpture 1.

Initial motif. Probably a variation of the ascension motif. Figure is seated on an elevated platform adorned with elements of the cosmic motif. Robed figure stands at left.

Initial date. 9.9.13.4.1 6 Imix 19 Zotz — St. 36, CR with upended frog glyph at C5.

Inaugural date. 9.10.6.5.9 8 Muluc 2 Zip — St. 33, CR at E1, F1, apparently no toothache glyph; St. 36, IS with toothache glyph at B8; St. 38, CR at B7b(?); L.2, implied by secondary series with toothache glyph at X9. Thirteenth tun anniversary — St. 34, PE at C9, connected by secondary series. Second katun anniversary — St. 38, CR at B9b (?).

Although the initial motif of this group is not a niche composition, it appears to be only a variation of the ascension theme. The principal figure is seated on a cushion placed on a pedestal with a plinth and an upper band or molding which may be a "sky band." Obscuring the outlines of the pedestal is an intricate design in which one can distinguish the head of the so-called Celestial Dragon, a limb with its cloven hoof, and a serpent fret, of a kind that is used also in the design on Stela 11. The ladder and the footprints are not evident. Above the figure there seems to be some sort of canopy. The figure is dressed in ceremonial garb and holds an object that most probably is a bag, so that its pose, with the exception of the head turned over the right shoulder, resembles closely the pose of figures in niches.

The inscription on the sides of Stela 33 is eroded, and the inaugural date appears only on the front, where the toothache glyph does not seem to accompany it. The association of the date and the glyph on Stela 36, however, is perfectly clear.

The separation of the last two stelae from the group is irregular, but Stela 39, which records a sequent hotun, is clearly not an ascension stela, but one with a "warrior" figure. Moreover, Andrews (1942) has linked the inscription on Stela 38 to that of the group by a katun anniversary, which shows the inscription to be part of this series.

Series 3

Monuments. St. 6 — 9.12.15.0.0; Alt. 1 — 9.13.0.0.0; St. 2 — 9.13.5.0.0(?); St. 4 — 9.13.10.0.0; St. 1 — 9.13.15.0.0; St. 3 — 9.14.0.0.0; St. 5 — 9.14.5.0.0; St. 7 — 9.14.10.0.0; St. 8 — 9.14.15.0.0.

Location. Stelae aligned in front of Str. J–4; altar in plaza below terrace.

Associated inscriptions. Shell plaques from Burial 5; carved jade from Sacrificial Cenote at Chichén Itzá (Proskouriakoff 1944).

Initial motif. Ascension, with cosmic motif. A robed (?) figure on one side of the monument.

Initial dates. (1) 9.11.12.7.2 2 Ik 10 Pax — St. 6, CR, possibly preceded by upended frog glyph at X7 (?), see remarks for suggested decipherment; St. 8, IS with upended frog glyph at A9. Fifty-seventh tun anniversary — St. 7, PE at D9, C10. Third katun anniversary — St. 8, at C19, D19.

(2) 9.12.2.0.16 5 Cib 14 Yaxkin, associated with robed figure — St. 1, IS with upended frog glyph at B3; St. 3, IS with upended frog glyph at A8; inscribed shells, CR with upended frog glyph at B1.

(3) 9.13.16.4.6 4 Cimi 14 Uo, possibly referring to small figure on throne — St. 3, CR with upended frog glyph at D6.

Inaugural date. 9.12.14.13.1 7 Imix 19 Pax — St. 6, CR at W10, X10, see remarks for suggested decipherment; St. 3, CR at I6, J6; St. 7, CR at C6; St. 8, CR with toothache glyph at I3(?). First katun anniversary — St. 1, CR at G8, G9; St. 8, PE at U1, V2. Fifth hotun anniversary — St. 3, PE at I10, J11.

Morley reads W8 on the right side of Stela 6 as 2 Ahau. The glyph at X8, however, has a coefficient of 10, and I suggest that this date reads 2 Ik 10 Pax and that it is the starting point of the secondary series at W6–W7. The revised inscription would read as follows:

W8X8	(9.11.12.7.2)	2 (Ik) 10 (Pax)
W6X6W7	1.2.5.19	
W10X10	(9.12.14.13.1)	7 (Imix) 19 (Pax)
W11	4.19(?)	
	(9.12.15.0.0)	(2 Ahau 13 Zip)

There are three initial dates in this series. The second initial date occurs as a second Initial Series on two monuments, Stelae 1 and 3. In each case it is associated with a robed figure depicted on the back of the stela. It is about nine years later than the first initial date, which presumably is associated with the figure on the front. The third initial date is over 33 years later than the second and is inscribed on the back of Stela 3, where next to the robed figure is another very small one (Fig. 4).

Series 4

Monuments. St. 11 — 9.15.0.0.0; St. 9 — 9.15.5.0.0; St. 10 — 9.15.10.0.0; St. 40 — 9.15.15.0.0; Alt. 2 — 9.16.0.0.0; St. 22(?) — 9.16.5.0.0.

Location. Stelae on platform in front of Str. J–3; altar in plaza opposite Str. J–2; St. 22 at Str. O–12.

Initial motif. Ascension, with cosmic motif. Human sacrifice at foot of ladder. On sides, a boy and two adult figures.

Initial date. 9.13.9.14.15 7 Men 18 Kankin — St. 11, CR preceded by upended frog glyph at F5a; St. 9, CR at C5, D5, possibly with upended frog glyph following secondary series at C3; Alt. 2, CR on south support, with upended frog glyph at A2.

Inaugural date. 9.14.18.3.13 7 Ben 16 Kankin — St. 11, CR with toothache glyph at E7; Alt. 2, CR on east support with toothache glyph at E2. Seventh tun anniversary — St. 9, PE at C11, D12. Katun anniversary — L. 3, IS and PE at F1.

This series is regular except for the uncertainty as to what happens after 9.16.0.0.0. Stela 22 is described as showing a standing figure and is dated 9.16.5.0.0. The case here may be like that of Group 2, whose last two monuments are in a different location. If Thompson's (1943) reading for Stela 14 is accepted, the next series of dates begins and ends with the hotun 9.16.10.0.0. If this reading is in error, Stela 23 may record this hotun, and the next group would begin with Stela 16, erected in 9.16.15.0.0. In the following, it is assumed that Thompson's reading is correct.

Series 5

Monument. St. 14 — 9.16.10.0.0(?).

Location. On terrace in front of Str. O–13(?).

Initial motif. Ascension, with cosmic motif and robed figure.

Initial date. Unidentified.

Inaugural date. 9.16.6.17.1 7 Imix 19 Uo (?) — St. 14, IS with toothache glyph at B11.

This monument stands alone unless at this time there were concurrent groups. The original placement of monuments in front of Structure O–13 is very uncertain, and the eroded inscriptions provide little additional evidence.

Series 6

Monuments. St. 16 — 9.16.15.0.0; St. 13(?) — 9.17.0.0.0; St. 17(?); St. 18 or 19(?).

Location. In front of Str. O–13; exact location uncertain. St. 16 is probably the first monument of the group aligned in the plaza.

Initial motif. Destroyed. Probably standing figure. Figure of boy and two adults on sides, as on St. 11.

Initial date. Unidentified.

Inaugural date. 9.16.12.10.8 6 Lamat 1 Mac — St. 16, CR with toothache glyph at C5.

A drawing made by Mary Butler of the front of Stela 16 seems to indicate that the figure is standing. If this is true, the association of the ascension motif with the inaugural date is broken at this time, but the traces of sculpture are so vague that a misinterpretation of the lines and their significance seems very possible. The entire pattern at this time becomes rather uncertain for there are more monuments in the plaza in front of Structure O–13 than can be accounted for on the basis of a single monument for each hotun. The next group apparently begins with Stela 15 on the summit of the pyramid, and this again is a standing figure.

Series 7

Monuments. St. 15 — 9.17.15.0.0; Altar 4(?) — 9.18.0.0.0; St. 12 — 9.18.5.0.0; probably others, unidentified.

Location. Known stelae on summit of Str. O–13; Alt. 4 in plaza.

Associated sculpture. Throne 1, in Str. J–6. Possibly Lintels 1 and 3.

Initial motif. High relief standing figure holding bag.

Initial date. 9.15.18.16.7 12 Manik 5 Zotz — Throne 1, with upended frog glyph at Q1. Forty-sixth tun anniversary — St. 12, PE with upended frog glyph at B21a.

Inaugural date. 9.17.10.9.4 1 Kan 7 Yaxkin — Throne 1, CR with toothache glyph at G13. St. 15, toothache glyph at B1; preceding date destroyed. Possibly 9th tun anniversary on St. 12 at D19.

The series begins with a standing figure, but this figure is neither a warrior nor a grain-scatterer. It is carved in unusually high relief and is shown holding a bag, as do the seated niche figures. The ascension motif may have been expressed by its high position on the pyramid or on surrounding architectural features.

After the assignment of stelae in front of Structure O–13 to the hotuns intervening between Stelae 16 and 15, there remain six unassigned monuments: Stelae 18 or 19, 20, 21, and 23; Altars 3 and 5. If these monuments belong to Series 7 its record could be extended to 9.19.10.0.0 or 9.19.15.0.0. It is possible, however, that Series 7 is not the last and that another series is represented.

Odd Occurrences of Upended Frog and Toothache Glyphs

Lintel 1. Upended frog glyph and three other glyphs in association with a female figure. No associated date.

Lintel 2. Toothache glyph at K'1 without affixes and with animal head as main element; first in panel of five glyphs probably referring to minor figure behind the chief warrior. No associated date.

Lintel 3. Toothache glyph at A'1 following secondary series counted from 2 Cauac 2 Muan, and possibly also immediately after this date. The long count position suggested by Morley is 9.16.6.10.19, 122 days before the inaugural date of St. 14 (Series 5). The IS on this lintel records the first katun anniversary of the inaugural date of Series 4, and as Thompson (1944a: 77–8) has shown, the record continues at least to 9.17.11.6.1, which is a tun anniversary of a date on Throne 1 (Series 7). Thus, the inscription on L. 3, unlike the stela inscriptions, is not limited to dates of a single series.

Discussion and Speculations

The data summarized in Figure 1 and Table 1 lead to the following observations:

1. That the ascension motif at Piedras Negras marked the beginning of a series of monuments dealing with a sequence of related dates, and that the motif symbolized an event that recurred at irregular intervals and was of some civic and religious importance.

2. That the earliest date relevant to a series was marked by the upended frog glyph, and was some distance in the past when the ascension motif stela was set up. Later dates marked by the upended frog glyph, and also called initial dates, begin records dealing with subsidiary figures.

3. That the ascension motif is associated with a date which falls in the hotun preceding its erection. This date, called the inaugural date, probably, though not necessarily, is the date of the event symbolized by the ascension.

4. That the initial and inaugural dates are normally repeated and celebrated by anniversaries only within the series in which they occur, the inscription on Lintel 3 being unusual in this respect.

5. That the distance between the initial date of a series and the inaugural date of the next does not exceed the limits of a reasonable lifetime.

These observations indicate that at least some of the events dealt with in Piedras Negras inscriptions are periodic, but not cyclical, and that each series can be construed as recording a sequence of events in the life of a single individual. Inference carries us no further, but if we make some basic assumptions, we can explore a hypothesis without commitment, and it is in this spirit that the following interpretations are offered, without claim that they are the only possible interpretations or even that they are the best that can be devised.

The first assumption made is that the inaugural date celebrates the accession of a new ruler. The ascension motif seems peculiarly appropriate to express such a theme, especially in view of certain passages in the Books of Chilam Balam that refer to the "seating" of rulers. From Roys' translation of the rise to power of Hunac Ceel (Roys 1933: 75), one might quote the following phrases (italics mine): "Then they began to declare him ruler. Then *he was set in the seat of the rulers* by them." And further: "Then they began to set aloft the house on high for the ruler. Then began the construction of the stairway. Then *he was set in the house on high* in 13 Ahau, the sixth reign." Elsewhere there is mention of the "Jaguar mat" in connection with office, and the markings of a jaguar pelt can be clearly seen on the cushion on which the ruler is seated on Stela 25.

If the inaugural date celebrates the accession of a ruler, the initial date, which falls between 12 and 31 years earlier, must represent an event that happened early in the ruler's life, possibly even his birth, though more probably some ceremony corresponding to baptism or to his initiation into formal training. Years counted from initial dates will therefore be regarded as "ages" of the individuals concerned, with the understanding that they may fall somewhat short of ages counted from birth.

On the basis of these assumptions, the fourth column of Table 1 shows that the lengths of successive reigns were about 35, 47, 42, 28, 5, and 17 years, averaging to a reign of 29½ years. Where relevant figures are known, the ages of rulers at accession are shown in the first column of Table 1 to be roughly 12, 22, 28, and 31 years. Their lifetimes, measured from initial dates to inaugural dates of the next series, are 60, 64, and 56 years, and the distances between generations of rulers, 38 and 36 years. The last two figures, associated with long reigns, suggest that the succession was not always from father to eldest son, since the figures are too high to represent normal distances between generations. The lifetimes and the reigns indicated are also of greater length than one would expect, and it is possible that sometimes on the death of a ruler the reign was continued by a younger brother, as Landa describes happening in Yucatán (Tozzer 1941: 100), without the event calling for a new accession monument. Nevertheless, even if the figures refer to single individuals, they are well within the bounds of possibility for a limited period, and in default of evidence to the contrary it will be assumed that the principal figures of a group of monuments all portray the same person.

Thus one can envisage Stela 25 with its ascension motif as representing the accession of a ruler, whose portrait a katun later appears on the companion Stela 26 in the guise of a "warrior" with two prisoners at his feet, apparently symbolizing an aggrandizement of his power or some exploit of valor. Fifteen tuns later, with Stela 33, begins the longest reign recorded. The incumbent ruler at the time of his accession was not yet 13 years old, and perhaps because of his youth, he is shown with a robed figure beside him. If we knew the initial date for Stela 14, which shows a similar robed figure, we could check this interpretation, but that date, unfortunately, is unknown.

Robed and skirted figures on Maya stelae have always posed a problem, for some scholars have been reluctant to accept them as figures of women. This reluctance hardly seems justified since the discovery of the Bonampak murals, in which a woman and a child play an important role in the ceremonies depicted (Ruppert, Thompson, and Proskouriakoff 1955). There is also confirmation of the female sex of robed figures in hieroglyphic passages associated with them, which almost always contain female head glyphs. The inscription on the front of Stela 33 contains one of these glyphs. Evidence on this will be presented later, and at this time it will be assumed that all the robed figures at Piedras Negras represent women.

On Stela 32, the ruler is shown holding a shield. There is a robed figure on the right side of the monument, possibly the same as on Stela 33, but more probably a wife of the young man, who was then 21 years old. Five years later, he is shown on Stela 34 with a shield and hatchet. The next monument is glyphic and we have no portrait of the ruler in this hotun but when he had reached the age of 36, on Stela 35, he seems to have gained considerable

TABLE 1. SUMMARY OF DATE INTERVALS AT PIEDRAS NEGRAS.

Series	*Initial Date to Inaugural Date, Same Series*	*Initial Date to Initial Date, Next Series*	*Initial Date to Inaugural Date, Next Series*	*Inaugural Date to Inaugural Date, Next Series*
1	?	?	?	1.15.16.13 (35+ years)
2	13. 1. 8 (12+ years)	1.19. 3. 1 (38+ years)	3. 1. 9. 0 (60+ years)	2. 8. 7.12 (47+ years)
3	1. 2. 5.19 (22+ years)	1.17.7.13 (36+ years)	3. 5.14.11 (64+ years)	2. 3. 8.12 (42+ years)
4	1. 8. 6.18 (28– years)	?	2.17. 2. 6 (56+ years)	1. 8.13. 8 (28+ years)
5	?	?	?	5.11.17 (5+ years)
6	?	?	?	17.16.16 (17+ years)
7	1.11.10.17 (31+ years)	?	?	?

weight, and is depicted as a warrior with a prisoner at his feet. The reign of this ruler lasted for 47 years, and he would have been 60 if he were still living when the next ruler acceded.

This ruler, shown on Stela 6 (Fig. 3), was 22 years old. On the side of the monument is depicted another figure, but it is not altogether clear whether it is that of a man or a woman. A lahuntun later, on Stela 2, on which the main figure is shown with a gesture of scattering grains, the figure on the left side clearly wears a robe, and on the top of the monument there is a curious little figure that seems to be sitting in a tub or basket. One is led to wonder if this might represent the first born of the royal pair. If so, he never succeeded to the throne, for the initial date of the next ruler was still four and one-half years ahead. When Stela 4 was erected, the ruler was 37, and, as befits his age and rank, he is shown as a warrior with two prisoners. On the next two monuments, Stelae 1 and 3, his portrait is eroded, but two portraits of the woman who was probably his wife are excellently preserved on the back of the monuments. The initial date that goes with these portraits shows the woman to have been nine years younger than her husband, and 37 years old at the time of the erection of Stela 3. On this stela (Fig. 4), she is shown sitting on a throne with a small child beside her, a little girl, three years old, as indicated by a second initial date recorded on this monument.

This unusual representation and the next, on Stela 5, may indicate that at this time there was no natural successor to the throne. Stela 5 shows a young man confronting the ruler, who is seated on a jaguar throne surrounded by cosmic or dynastic symbols. If this composition can be construed as expressing the appointment of a new successor, it can be shown by the initial date of the next series that he was at this time 15 years old.

On the next two stelae in this group the ruler is shown in the guise of a warrior with prisoners (Fig. 5), and then on Stela 11, the successor assumes his rule at the age of 28. On the left side of the monument is shown a young man or boy, who presumably is his heir, and on the right are two adult figures. One of these, by his paunchy build, calls to mind the fat slave or eunuch in charge of the child on the Bonampak murals, and suggests that the adult figures may represent tutors or guardians of the boy.

Fig. 3. The ascension motif on Stela 6, Piedras Negras. Photograph courtesy of the Peabody Museum, Harvard University.

Stela 9, which follows, has the usual warrior-and-prisoner motif that seems to be used often with rulers over 30, but the next two monuments, Stelae 10 and 40, are very unusual in composition. Stela 10, erected in 9.15.10.0.0, shows a young man seated on a cushion and a jaguar standing behind him and extending a foreleg over his head. This motif is analogous to motifs on two Tikal lintels (Maudslay 1889–1902, Vol. 3, Pls. 71, 72), one of which is associated with the same lahuntun date. What this arrangement may signify it is hard to say. Stela 40, which was erected next, shows a bust of one figure on a throne, and another figure on the canopy above, scattering grains. What seems to be suggested is some delegation of power, perhaps a temporary subservience to a foreign potentate, perhaps an acting head of government appointed to carry on the functions of an incapacitated ruler. The end of this reign and the beginning of the next is clouded partly with uncertainties of decipherment but also with apparent complications of succession. Lintel 3 (Fig. 6), though carved much later, probably recounts what happened. Its inscription begins with the katun anniversary of the inaugural date of Stela 11, falling soon after the erection of Stela 40. A gathering or council is shown, and in the background panel of glyphs we recognize the toothache element. The date associated with this element is not placed in the long count, but if Morley's suggested position is correct it falls only 122 days before the inaugural date on Stela 14, and perhaps is not itself an accession date but that of the council at which the decision of succession was made. If our interpretation of the robed figure on Stela 33 is correct, the chosen ruler on Stela 14 was very young at the time, and could have been one of the children shown on Lintel 3.

FIG. 4. Figure of woman and child on the back of Stela 3, Piedras Negras, with accompanying record. Photograph courtesy of the Peabody Museum, Harvard University.

He did not rule long, however, for on Stela 16, erected only a hotun later, there is another inaugural date. The face of this monument is badly eroded, but the arrangement of figures on the sides is almost identical to that on Stela 11, showing a boy and two adults. If we assume that the boy is the ruler whose initial date appears on Throne 1, we find him to be 16 years old at the time. The age of the ruler himself is not known, but judging by the grain scattering motif, on Stela 13, he probably was still a young man, for on Stela 2 this motif occurs near the beginning of a series and after a ruler passed the age of 30 he seems to have been shown more often as a warrior with prisoners.

Stela 15 is probably the accession stela of the next ruler, whose dates appear on Throne 1. He was 31 years old at accession, and was 45 when, on Stela 12, he is shown arraigning prisoners in charge of two assistants.

Stela 12 is the last well-preserved monument at Piedras Negras, but there remains to be

mentioned one additional association of a figure with dates that seem to imply its age. This is the figure of the prisoner kneeling at the left of the principal figure on Stela 8. The prisoner is bearded, emaciated, and appears to be very old. Behind him, on the border of the monument are two dates connected by a secondary series of 4.8.2.14 (almost 87 years). This series is not connected to the main inscription, but apparently begins about 25 years before the initial date of this inscription and ends within a year of its final hotun date. Morley (1937–38) does not make clear in his publication if any identifying glyphs occur with the first date. His diagrams show four glyphs in the upper group, but only two are drawn. It is possible, therefore, that a glyph identifying this date was present, and that the age of the prisoner was indicated.

Fig. 5. The "warrior" motif on Stela 7, Piedras Negras. Photograph courtesy of the Peabody Museum, Harvard University.

These interpretations show that the motifs of sculpture at Piedras Negras are entirely consistent with the theme of dynastic succession. None of the events, however, have been substantiated and another set of assumptions may produce a totally different but equally successful hypothesis. I have seriously considered the possibility that an ascension stela may represent human sacrifice and the apotheosis of the victim, but have found it difficult to account for the presence of figures of women and children in such a context. The stress on the familial theme, if it is accepted as historical, leads inevitably to matters of genealogy and the attainment of pre-eminent status.

Whether similar themes, less realistically expressed, are characteristic of other Maya cities, I have been unable to determine. The toothache glyph occurs sporadically at other sites but no articulated sequence of inaugural dates can be found. At Naranjo there is some evidence of discrete chronological series, but the grouping of the monuments and the pattern of the dates of their erection are different from those observed at Piedras Negras, and many inscriptions are inadequately recorded.

Naranjo

Naranjo stelae were often set up in pairs, one of each pair presenting a male figure, the other a figure wearing a skirt, and the inscriptions of both ending on the same date. Male figures sometimes occur singly or grouped together, but all skirted figures have potential mates, though the erosion of inscriptions sometimes makes it difficult to prove their affiliation. The stelae of a pair sometimes stand side by side, sometimes face to face across a small plaza, and some-

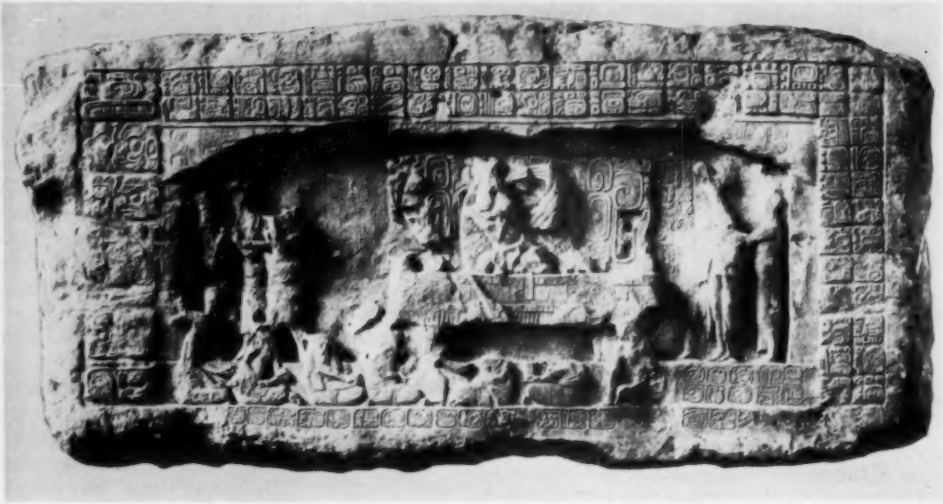

FIG. 6. The council or audience scene on Lintel 3, Piedras Negras. Photograph courtesy of the University Museum, Philadelphia.

times flanking other monuments previously set up. A series of monuments dealing with related dates is not limited to a single group, but may include several groups widely separated from each other. In the following summary, figures wearing a loincloth apron are identified as male, and those wearing skirts as female.

Series 1

Monuments. Group 1: St. 22, male, St. 24, female — 9.13.10.0.0; St. 21, male — 9.13.15.0.0; St. 23, male — 9.14.0.0.0. Group 2: St. 30, male, St. 29, female — 9.14.3.0.0; St. 28, male, St. 31, female — 9.14.10.0.0. Group 3: St. 2, male, St. 3, female — 9.14.1.3.19(?); St. 1, male — 9.13.10.0.0(?).

Location. St. 24 in front of Str. C–VII, facing St. 21, 22, 23 aligned in East Plaza in front of Str. C–VI; St. 28, 29, 30, 31 aligned on terrace in front of Str. C–IX; St. 1, 2, 3 aligned in front of Str. A–XV on West Plaza.

Initial date. 9.12.15.13.7 9 Manik 0 Kayab — St. 22, male, IS with upended frog glyph at F6; St. 24, female, CR with upended frog glyph at B13; St. 29, female, CR with upended frog glyph at H8.

Inaugural date. None identified. At F18 on St. 23, with the date 1 Men 13 Yaxkin (9.13.18.9.5), is a glyph that may be a variant of the toothache glyph, but its identity is uncertain (Fig. 7). The distance of this date from the initial date is 1.2.13.18 (22+ years).

Other prominent dates. (1) 9.12.10.5.12 4 Eb 10 Yax — IS with female figures on St. 24, 29, and 3. It is the earliest date recorded, but not an initial date.

(2) 9.13.1.3.19 5 Cauac 2 Xul — St. 22, male, CR at E9,F9; St. 21, male, IS. Katun anniversary — IS of St. 2, male.

The initial date is preceded by another on stelae with female figures, but, as at Piedras Negras, it is the earliest date accompanying a male figure, and was 14 years in the past when it was recorded on Stela 22. It is not mentioned again with male figures, and a date about 5½ years later is celebrated by anniversaries in its stead. Another important difference with the pattern of Piedras Negras is the absence of an inaugural date on the first stela. If one is recorded at all, it is on the final stela of Group 1, Stela 23.

Series 2

Monuments. Group 1: St. 13, male — 9.17.10.0.0; St. 14, male — 9.18.0.0.0; St. 12, male — 9.18.10.0.0. Group 1a: St. 33, male, St. 34, female — 9.17.10.0.0(?). Group 2: St. 6, male (date unknown); St. 8, male — 9.18.10.0.0; St. 7, male — 9.19.0.0.0. Group 2a: St. 10 — all-glyphic, 9.19.0.0.0; St. 11, female (date unknown).

Location. Group 1, aligned in Middle Plaza in front of Str. B–XIX. Group 1a, Middle Plaza in front of Str. B–XX, with plain Stela B2. Group 2, in Court of Hieroglyphic Stairway, aligned in front of Str. B–IV. Group 2a, at other end of court in front of Str. B–XXIII.

Initial date. 9.17.0.2.12 13 Eb 5 Zip — St. 10, CR with upended frog glyph at A2; St. 12, CR with upended frog glyph at B.2.

Inaugural date. 9 ——— 11 Muan, long count position unknown — St. 6, CR on front with toothache glyph at A3. Following the IS of St. 14, 9.17.13.4.3 5 Akbal 11 Pop, is a glyph that may be a toothache element without affixes, but the identification is uncertain. The distance of this date from the initial date is 13.1.11 (12+ years).

The date on Stela 6 is read by Morley as 9 Ahau 13 Muan, but, in my opinion, the month coefficient is better read as 11. If this is the inaugural date for the series, its most probable positions are: 9.18.4.2.13 9 Ben 11 Muan and 9.18.17.5.18 9 Eznab 11 Muan. These positions, however, seem rather late for the style of the monument.

Series Undetermined

Monument. Stela 20.

Location. In front of Str. B–XIII.

Inaugural date. 7 Cib 19 Chen or Yax — CR with toothache glyph at A4. Long count position unknown.

As I have pointed out elsewhere (Proskouriakoff 1950: 126–7) the date proposed by Morley for this stela does not accord well with its style, which is similar to that of Series 1. The best positions for the date on the front are: 9.13.17.11.16 7 Cib 19 Chen and 9.12.17.7.16 7 Cib 19 Yax.

Series Undetermined

Monument. Stela 32.

Location. In East Plaza in front of Str. C–IX.

The composition of this late monument suggests that it may correspond to the ascension motif of Piedras Negras and may begin another series. The stela dates from 9.19.10.0.0, but no relevant intermediate dates have been identified.

Discussion and Speculation

Until dates are better deciphered at Naranjo the pattern cannot be successfully compared with that of Piedras Negras. The inaugural dates at Naranjo do not appear to have been marked by a distinctive motif, nor is there any indication that they or initial dates were celebrated by anniversaries. The initial date, however, appears to retain an early position in the series, apparently the earliest that refers to a male figure. If we follow the interpretation suggested for Piedras Negras, the woman on Stelae 24, 29, and 3 is evidently of an older generation than the man on Stelae 22, 30, and 2.

Terminal dates do not run in a sequence of consecutive hotuns as they do at Piedras Negras, and are sometimes odd dates or their anniversaries. The assumption that every terminal date represents the date of the erection of the monument on which it is found does not seem justified here. In the case of Group 2, Series 1, the distribution of dates suggests that the whole group may have been set up as a unit on the lahuntun which ends the record as a whole. On the two monuments with male figures, Stelae 30 and 28, between 9.14.0.0.0, when the record begins, and 9.14.10.0.0, when it ends, 14 dates are inscribed in sequence. Of these dates, 13 fall in the first hotun, and only one after 9.14.5.0.0. Perhaps the date 9.14.-3.0.0 was chosen for the end of the first inscription merely to distribute these dates more evenly on the monuments. This would presuppose that the group had been planned after the recorded events had taken place. It seems quite likely that monuments at Naranjo were normally erected regularly at lahuntun intervals and that a number were set up simultaneously to take a single record, their terminal dates being not "dedicatory dates" but merely intermediate stopping places in a single historical record.

Thus, Group 1 of Series 1 may have covered the lahuntuns 9.13.10.0.0 and 9.14.0.0.0. Group 2 was probably set up in 9.14.10.0.0, and Group 3, where the date 9.14.1.3.19 seems to end at least one inscription, may have carried the count forward to 9.15.0.0.0. In Series 2, Stelae 13, 33, and 34 may have been erected at one time, with Stelae 14 and 12 added at lahuntun intervals. Groups 2 and 2a may have been set up in 9.19.0.0.0, though in this case the stylistic variation in the monuments makes me suspect that Stela 6 is earlier.

Records from Other Sites

El Cayo

Initial date. 9.16.0.2.16 6 Cib 9 Mol — L. 1, IS with upended frog glyph at A9.

Inaugural date 1(?). 9.16.12.14.10 5 Oc 3 Yaxkin(?) — L. 1, CR with toothache element at E4. Distance is 12.11.14 (12+ years).

Inaugural date 2(?). 9.17.1.5.9 1 Muluc 17 Tzec(?) — CR with toothache element at K15. Distance from initial date is 1.1.2.13 (20+ years).

This is the only known case of two inaugural dates occurring in one inscription. Like that on Lintel 3 at Piedras Negras, this record may span the period of two "reigns." The variant forms of the toothache glyphs, however, give warning that one or both references may be not to an inaugural date but to one in some way related to it (Fig. 7).

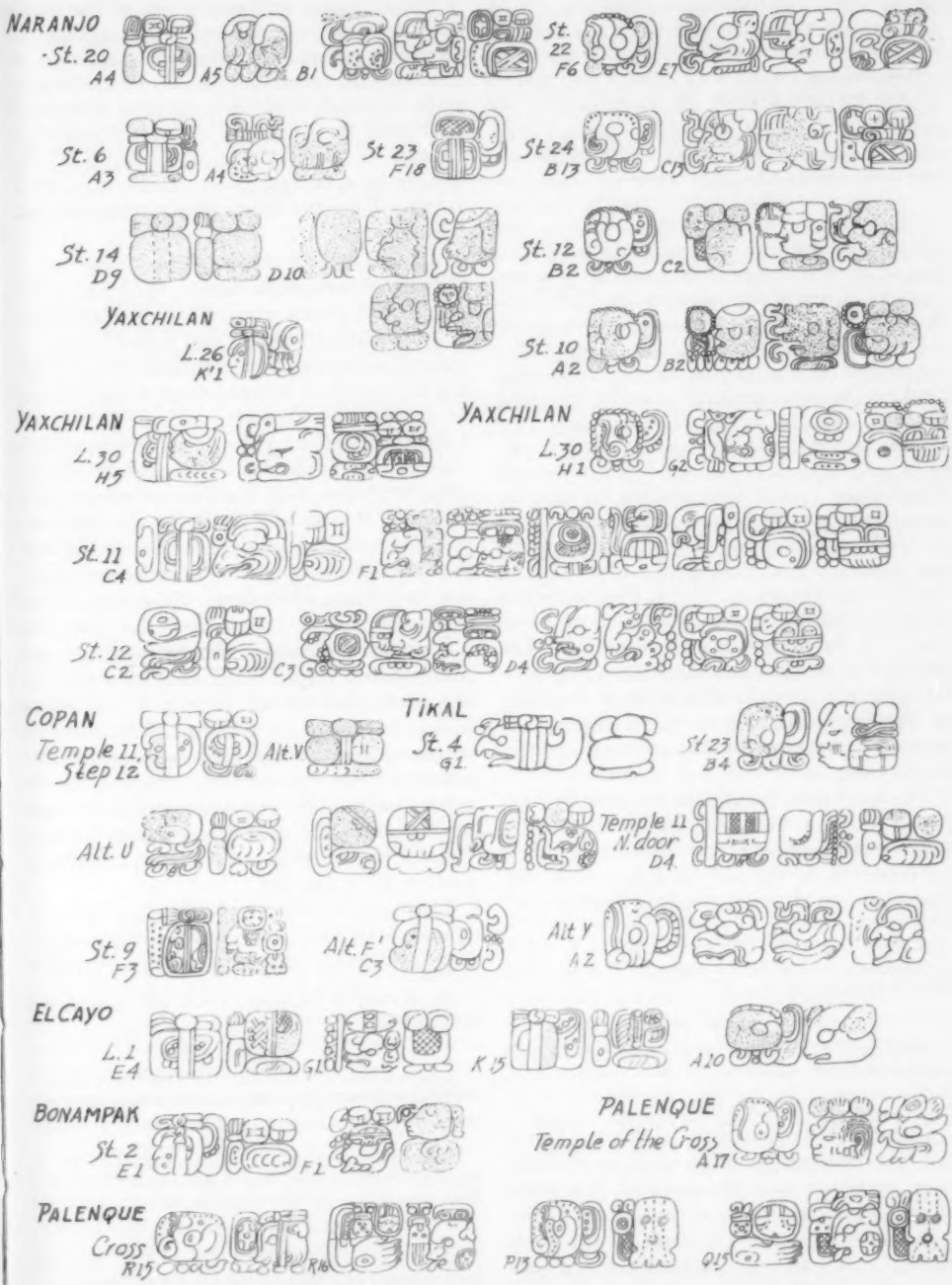

FIG. 7. Glyphic expressions associated with the toothache glyph and the upended frog glyph at various sites.

Yaxchilán

Initial date. 9.13.17.12.10 8 Oc 13 Yax — L. 30, CR with upended frog glyph at H1.

Inaugural date. 9.16.1.0.0 11 Ahau 8 Tzec — L. 30, CR with toothache glyph at H5a; St. 11, IS with toothache glyph at O4, and second IS; St. 12, CR with unknown glyph followed by affix cluster at D2; L.1, CR without toothache glyph; Alt. 4, IS; Alt. 14, IS. Distance from initial date is 2.3.5.10 (42+ years).

This very important inaugural date at Yaxchilán falls just at the time when at Piedras Negras there is some sort of irregularity in succession. Comparing phrases on Yaxchilán Stelae 11 and 12 with those on Piedras Negras Altar 2, Throne 1, and Lintel 3, we find a number of similar glyphs, among them what I take to be the hieroglyph that Berlin (1958, Fig. 28) identifies as the "emblem glyph" for Piedras Negras, though he distinguishes the form used at Yaxchilán as a different symbol. I find it also very striking that the bat and the jaguar head at D4C5 on St. 12 (Fig. 7) recur at A'2Z3 on Lintel 3 at Piedras Negras. I venture to suggest that these glyphs refer to one of the lords of Yaxchilán, who at Piedras Negras either headed the council represented on Lintel 3, or was the subject of its deliberations. The presence of two emblem glyphs in phrases referring to this person and to some of the rulers of Yaxchilán, suggests to me a close union between the ruling families of the two cities at this time.

The toothache element in an unusual compound occurs at Yaxchilán on Lintel 26 at K'1 (Fig. 7) and variants of the upended frog glyph on Lintel 35 at V6 and on Lintel 42 at E3. These are not directly associated with dates.

Bonampak

Inaugural date. 9.17.5.8.9 7 Muluc 17 Yaxkin — St. 2, CR with toothache glyph at E1.

Kuna

Initial date. 13 Chicchan 13 Yaxkin — L.1, CR with upended frog glyph at M1.

Palenque

There are a number of initial dates at Palenque, but their long count positions are in many cases uncertain, and the upended frog often follows secondary series, where its association with a date is not always clear. The Temple of the Cross inscription seems to deal specifically with initial dates, the earliest of which falls before 4 Ahau 8 Cumku. The record is discontinuous, and only a few of the initial dates seem to be connected to earlier dates by secondary series. An adequate discussion of the Palenque initial dates would be too lengthy to be included here. A distinctive compound containing the toothache element occurs in a number of records (Fig. 7, Cross, R15S15), usually in a context of other non-calendrical glyphs. I do not know of an inaugural date clearly recorded.

Copán

The very important date, 9.16.12.5.17 6 Caban 10 Mol, which occurs seven times at Copán and is celebrated by a katun anniversary on Altar T, is probably an inaugural date, though the inscription on Altar U seems to make it also an anniversary. On a step in Structure 11, it is followed by a glyph that includes the toothache element, and in Gordon's illustration of Altar V (Fig. 7; Gordon 1902, Fig. 20) the eroded glyph following it looks as if it may be the toothache form. Elsewhere, the date seems to appear without affiliation with a toothache element, but the typical affix cluster of inaugural dates is used on Altar U with a glyph that resembles Thompson's "seating of the haab" glyph, and again after a record of six tuns on a jamb of the north doorway of Temple 11. It seems likely, therefore, that 6 Caban 10 Mol was an inaugural date, though references to it do not always include the toothache element. Toothache elements in various compounds unassociated with dates occur at Copán on Stela 9 at C9 and F3, and on Altar F' at C3 (Fig. 7; Gordon 1902, Fig. 26).

Initial dates. (1) 9.10.19.5.11 10 Chuen 4 Cumku (Thompson 1944b) — St. 3, second IS with upended frog at A7b. Eleven days after date of first IS. Reading uncertain.

(2) 6 Cimi 19 Uo — Alt. Y, CR with upended frog glyph at A2.

Seibal

Inaugural date(?). 9.17.0.0.0 13 Ahau 18 Cumku — St. 7, CR with toothache element in odd compound at A2.

Pusilhá

Initial date. 9.7.12.6.7 8 Manik 10 Kayab — St. H, second IS with upended frog glyph at D14. Distance to dedicatory date is 3.7.11.13 (66+ years).

Morales

Initial date. 9.13.19.8.1 2 Imix 14 Tzec — St. 2, IS with upended frog glyph at B9 and at C8, following secondary series. Distance to dedicatory date is 1.0.9.19 (20+ years).

Pestac

Initial date. St. 1, upended frog at D4; date undeciphered; follows secondary series of over 2 katuns.

Toniná

Initial dates. (1) 9.16.5.4.9 6 Muluc 17 Mol — St. 20, CR with upended frog at D4. Distance to dedicatory date is 1.14.13.11 (34+ years).

(2) 12 Oc or Men 3 Zotz(?) — St. 30, CR with upended frog at A4.

Tikal

Inaugural date(?). 8.17.2.16.17 5 Caban 10 Yaxkin or 9.3.1.10.2 5 Ik 10 Yaxkin — St. 4, CR with toothache element at A5.

Initial date. 9.3.9.13.3 8 Akbal 11 Mol — St. 23, IS with upended frog at B4. I am indebted to Linton Satterthwaite, Jr., of the University Museum, Philadelphia, for the readings of these two dates.

This list is incomplete. There are some toothache elements and many more upended frog glyphs for which date associations could not be found. J. E. S. Thompson, who very kindly supplied me with a list of the incidence of the two glyphs from his as yet unpublished dictionary of Maya hieroglyphs, and with several suggested readings of dates, cites in his list 31 examples of various toothache element compounds and 81 examples of the upended frog glyph, exclusive of its use in lunar series. In addition he calls attention to the toothache element in Codex Madrid 90a–93a, and in Codex Dresden 23b and 67a. In the Dresden, the toothache elements are followed by designations of gods, and on page 23b, various food offerings seem to be the subject of the text.

Glyphic Implications of the Dating Pattern

The fact that the toothache glyph and the upended frog glyph are associated with certain dates in an ordered pattern indicates quite clearly that they signify events of a recurring nature. Thompson (1950: 264) notes that in divinatory almanacs in the codices, the first glyph of successive phrases is usually a glyph denoting some action or happening, and the toothache glyph holds precisely this position on Dresden 23b and 67a. Here the toothache element appears without affixes and is followed in each case by the designation of one of the gods. On the monuments, the expression is somewhat more complex, but the same order of the action glyph and the appellative holds, although the appellative is not one of the known god names and probably refers to the ruler of the city or district, since it changes with each set of records.

The first column of Figure 2 shows phrases that follow inaugural dates at Piedras Negras. The toothache glyph stands immediately after the date and is recognized by the vertically tied main element. The normal form is best exemplified on Altar 2, where the glyph is seen to have a "ti" prefix, a "ben-ich" superfix and a suffix that is more clearly rendered on Stela 36. Here it is clear why Thompson called this the "toothache glyph," for the tied element is the head of a vulture, a bird that also appears as a separate form following the toothache element on Stela 11 at Yaxchilán. It is used also in a cartouche for the day Ahau (Piedras Negras L. 3, V4, and St. 15 on pouch) and in place of the tun element of the katun (St. 3, F3). On Lintel 2 it ends three passages designating warriors who kneel before their leader. The vulture, therefore, may be something in the nature of a title or a clan symbol. There is also on Lintel 2 at K′1 a toothache glyph in the form of an animal head, but in later inscriptions the bound element tends to resemble the abstract "lunar" form.

In three cases, a so-called "lunar" postfix is added to the normal form of the glyph. I am not sure what circumstances determine its use or omission, but it occurs consistently with predicate glyphs, that is, with glyphs that immediately follow dates and that tend to be associated with certain motifs in sculpture. Various investigators recognize it as a verbal postfix, and Knorozov (1958a: 285) gives it the value *h(a)* or *ah*.

On Lintel 2, Stela 15, Throne 1, and Lintel 3 at A′1, the toothache glyph is expanded into two characters. The first contains the toothache element with varying postfixes, and the second is made up of the affixes contained in the single form. When an anniversary of an inaugural date is recorded (L. 3, G1; St. 3, F1; Cenote Jade), only the affix cluster is used to denote the event; the toothache element is dropped. From this as well as from the fact that it is used alone in the codices, one may infer that the toothache element stands for a ceremony celebrating the event indicated by the affixes. For example, if the full phrase reads "the seating (of the ruler) on accession," the affix form following a period could signify "the anniversary of the accession" without mention

of the ceremony. The actual meaning of the terms is unknown, but some such construction is implied in the expansion and contraction of the forms.

In one instance at Yaxchilán (Fig. 7, St. 11, C4; St. 12, C2) and in another at Copán (Temple 11 step, Altar U), an inaugural date is followed in one record by the toothache glyph, and in another by a different character preceding the usual affix cluster. This character resembles one translated by Thompson (1950, Fig. 19, 37–51) as "the seating of the haab." Although it stands in the same relation to the date and to the affix cluster as the toothache element, it is not a substitute for it since the following glyphs are not those that stand after the toothache expression. Apparently another observance taking place on the same date is indicated by the variant clause. The diversity of statements accompanying inaugural dates makes them sometimes hard to identify, but it offers an excellent test for phonetic decipherments, which, if they are valid, should result in readings making clear the relation of the different forms and linking them to a common event.

The upended frog glyph, used with initial dates, varies less than the toothache glyph. When it stands immediately after a date, it always has the same suffix and the so-called "lunar" postfix. Sometimes, when it precedes the date or stands after a secondary series leading from it, as on Piedras Negras Stela 11 at F5a (Fig. 2), the lunar postfix is dropped, but this does not seem to have been mandatory, since at Palenque there are several examples of the upended frog glyph retaining the postfix after secondary series.

Additional glyphs referring to events or to ceremonies can be identified at Yaxchilán by their constant association with certain scenes portrayed on the lintels. Such glyphs always follow close upon the notation of a date. Among them is the "capture glyph" (Fig. 8 *a*) which frequently occurs with scenes showing the capture of prisoners or with figures holding a serrated spear. This glyph, like the upended frog glyph and the toothache glyph, takes a "lunar" postfix. A similar glyph in the codices has been read by Knorozov (1958a: 471, no. 15) as "*chucah*," past tense of "*chuc*," translated in the Motul dictionary as "*asir y prender, y echar mano, y tomar a uno en fragante delito, o hallarle en algún maleficio*," or "*alcanzar a otro siguiéndole*," or "*dar alguna enfermedad a alguno*." The glyph in Figure 8 *b* goes with representations of a serpent from whose jaws issues the head and torso of a human or grotesque figure. I suspect that this motif represents a rite performed in memory of a dead hero, since its glyph is often associated with a date far in the past. The form in Figure 8 *c* accompanies pictures of the blood-letting rite. Barthel (1955, note 95) notes a glyph of similar construction, but somewhat different form used with tongue sacrifices in the codices.

It seems safe to say that glyphs which immediately follow dates and especially those that tend to combine with the "lunar" postfix make reference to actions, events or ceremonies, and are essentially predicate glyphs. Following them we can expect to find substantives referring to the protagonists of the events, and if the representations are historical, some of these should be appellatives identifying the persons involved.

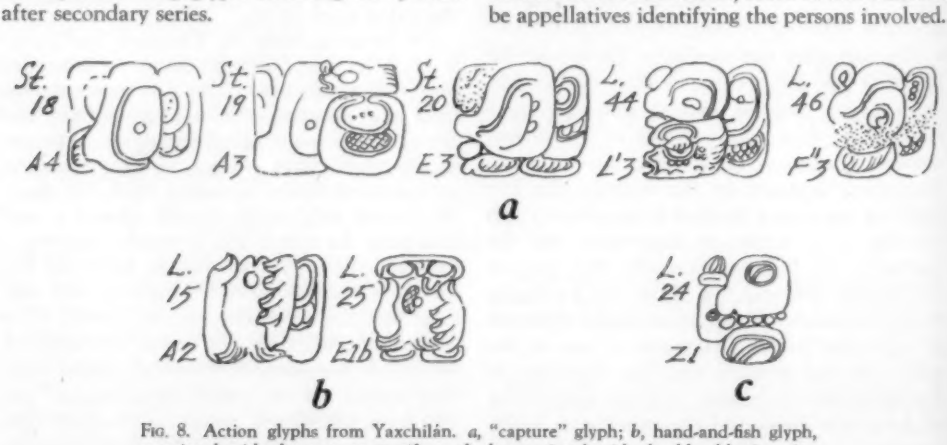

Fig. 8. Action glyphs from Yaxchilán. *a*, "capture" glyph; *b*, hand-and-fish glyph, associated with the serpent motif; *c*, glyph associated with the blood-letting rite.

In the records of Piedras Negras, the glyph that immediately follows the statement of the event is the same for initial and inaugural dates, but varies with each set of records (Fig. 2). On Stela 36 (C1—D5—) all three animal heads following the toothache element are identical to the heads after the upended frog glyph, and two of them appear also in the record on Lintel 2 at X5, which makes reference to the inaugural date of the same series. In other cases, there is some degree of variation in the glyphs following the first, but it seems to me no more than one might expect in a group of appellatives applied to a person in different stages of his life, a group including not only personal names, but also titles, kinship designations, and honorary or descriptive epithets. Many of the appellative glyphs are zoomorphic, consistent with Roys' (1940:35) comment that "many Maya patronymics are derived from well-known animals and plants." There are also abstract forms such as that heading the phrase on Throne 1 (H'3—R1—). This phrase is repeated on Lintel 3 (U11—); Thompson (1944a: 77–8) has read the last date on this lintel as falling within the contemporary record of the Throne 1 series. The inscription on the lintel also records an anniversary of the inaugural date of an earlier series represented by the phrase on Altar 2 (D3—), and the appellatives in the two notations are identical except for the omission of one glyph in the later inscription (L. 3, G2).

The last glyph of these phrases is the "emblem" glyph, identified by Berlin (1958) and associated by him with Piedras Negras. This glyph carries through several sets of records, but on Stela 36 it takes a different form, and I am inclined to think that it refers to lineage or dynasty rather than to place. Preceding the "emblem" in some instances is an anthropomorphic jaguar head, which varies in detail in different sets of records. It can appear alone, when it apparently makes brief reference to the person elsewhere designated by a group of appellatives. A corresponding glyph in a more natural form of a jaguar at Yaxchilán is of peculiar interest, and more will be said of it later. Here I merely want to point out that the study of the distribution of different forms contained in appellative phrases in respect to the different sets of records has at the very least the practical utility of aiding us in the reading of partially legible dates by limiting the span of time in which they can occur. Of even greater interest perhaps is the possibility of understanding the structure of nomenclature used by the ancient Maya and of tracing family relationships between the figures depicted in sculpture if our surmise concerning the appellative nature of these glyphic groups is correct.

In this connection, we should note that robed figures, which some have interpreted as male priests or penitents, are almost invariably associated with appellative glyphs prefixed by feminine heads, as on Stelae 1 and 3 (Fig. 2). These heads are identified as feminine by a hatched oval on the forehead, which corresponds to the black spot used in the codices to identify women, or by a more naturalistic depiction of a lock of hair. On Stelae 1 and 3, the first appellative is a katun sign prefixed by a feminine head. This has been read as "1 katun," but such a record here has little meaning. The katun sign is worn on the headdress by the figure on Stela 1, and I believe must serve as a name or title. Although "Katun" is not one of the known Maya names, Roys (1940) gives "Ix Nacan Katun" as "the name or title of the head of a celibate religious order of women" in Yucatán. I doubt, however, that the lady in question was celibate, for on Stela 3, she is shown with a child, whose names also are prefixed by feminine head glyphs. Inscriptions dealing with robed figures at Yaxchilán and with skirted figures at Naranjo contain similar glyphs prefixed by feminine heads, while appellative glyphs referring to male figures more often take zoomorphic or abstract forms. Heinrich Berlin, in a recent study of name glyphs at Palenque (MS) has reached the same conclusion on the function of some feminine head glyphs there.

Turning now to inscriptions at Yaxchilán, I want to point out another implication of the arrangement of records in distinct sets that can be identified by appellative glyphs. Berlin (1958) has noted the frequent occurrence here of two distinct phrases, one containing a jaguar glyph combined with a bird, a Cauac glyph, and the record of three ben-ich katuns (Fig. 9 *c*), and the other, a jaguar with a shield, a glyph with an Ahau element, and the record of four or five ben-ich katuns (Fig. 9 *a*, *b*). As an added or alternative glyph with the bird-jaguar phrase, there is a moon-like glyph, and with the shield-jaguar phrase, a death-head glyph. Many of the records at Yaxchilán contain only Calendar Round notations of dates, and it is reason-

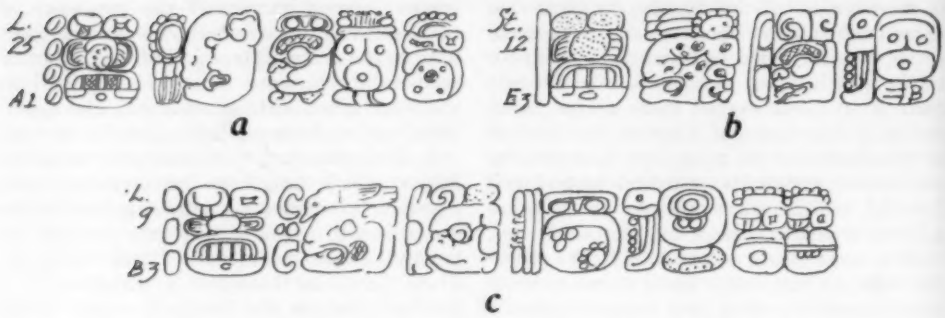

Fig. 9. Ben-ich katun notations from Yaxchilán. *a*, fourth ben-ich katun of the shield-jaguar; *b*, fifth ben-ich katun of the shield-jaguar; *c*, third ben-ich katun of the bird-jaguar.

able to suppose that the ben-ich katuns in the jaguar prhases serve to place these dates in the Long Count. The question of how this is done has been a thorn in the flesh of epigraphers for many years. I am not certain that even now we can reach a definite solution of the problem, but there is a cogent possibility that these katuns are to be counted from initial dates of records identified by the different jaguar phrases.

In the inscription on the shells from Burial 5 at Piedras Negras (Fig. 10), are two notations of four ben-ich katuns, one following the date 9.12.14.10.11 9 Chuen 9 Kankin, the other after 9.14.17.14.17 1 Caban 0 Mol (end of Yaxkin). Obviously these ben-ich katuns cannot both be counted from the same date, nor even from the beginnings of contiguous intervals. We can observe, however, that preceding the first notation is an anthropomorphic jaguar head which occurs in appellative phrases for the second and fourth series at Piedras Negras.

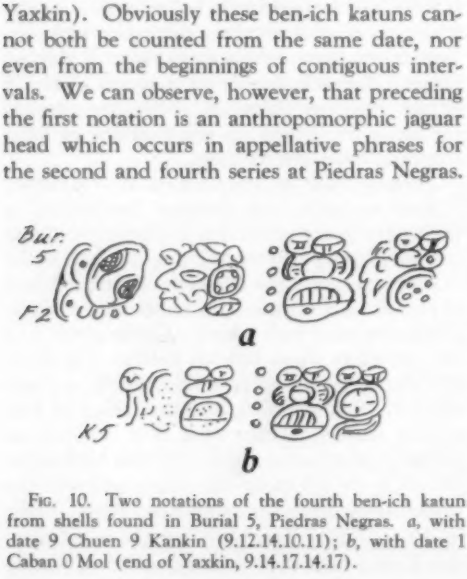

Fig. 10. Two notations of the fourth ben-ich katun from shells found in Burial 5, Piedras Negras. *a*, with date 9 Chuen 9 Kankin (9.12.14.10.11); *b*, with date 1 Caban 0 Mol (end of Yaxkin, 9.14.17.14.17).

Although the distinction between the two grotesque heads is not entirely clear, here it must be the second series which is meant, and counting from its initial date, we find that the date referred to falls in the fourth katun of the series. The second date belongs to the third series, and falls in the fourth katun from its initial date. The difficulty lies mainly in identifying the series or sets of records referred to, for neither here nor at Yaxchilán, is it always clear what particular glyphs identify the ruler or otherwise designate a reign.

On Lintel 30 at Yaxchilán, following the initial date, are the bird-jaguar and a moon-like glyph at G2,H2. The same glyphs recur on Lintel 31 at I1,J1, immediately after the inaugural notation of 11 Ahau 8 Tzec (9.16.1.0.0), and this time are followed by three ben-ich katuns (Figs. 7, 8). Since 9.16.1.0.0 does fall in the third katun after the initial date, this inscription bears out our hypothesis. On Stela 11, which records the same inaugural date, 9.16.1.0.0, we run into some complications. Morley's reading of Q13 as 7 katuns I believe can be rejected, since the vertical element here is clearly not a bar. One would expect, as on Lintel 31, the record of three ben-ich katuns, but the ben-ich element is not evident, even if we can restore the eroded coefficient as three. The Cauac glyph is here added to the jaguar phrase together with its constant predecessor, and the moon-like glyph is somewhat changed from the form it has on Lintel 30. On the front of the stela, the notation of three ben-ich katuns and the bird-jaguar places the date 9.15.19.1.1 correctly in the third katun, though this date actually precedes the inaugural date and would normally be recorded in connection

with an earlier reign. The moon-like glyph is dropped from this phrase. The relevance of the notation in the middle panel of the back of the stela is not clear. If it goes with the date 9.15.15.0.0 in the panel above, then our hypothesis is apparently contradicted, but there is already a record of five ben-ich katuns in the panel, preceding the bird-jaguar notation, so that the latter must refer to some other event.

The shield-jaguar and five ben-ich katuns are connected with the date 9.15.9.17.16 in a lower panel, and a similar notation with an added pair of glyphs including an Ahau element ends the inscription on the base, which records the inaugural date 9.16.1.0.0. The shield-jaguar and the Ahau element occur again with the male figure in the upper panel on the front of the monument, the portrait, no doubt, of the retiring ruler (Fig. 11), whose initial date must fall somewhere between 9.11.-1.0.0 and 9.11.9.17.15. On Lintel 56, the fifth katun of this jaguar is given with the date 9.15.6.13.1, thus lowering the upper limit of his initial date to 9.11.6.13.0. On the lintels of Structure 23, where an Initial Series 9.14.8.12.5 is recorded, the shield-jaguar phrase contains the record of four ben-ich katuns. This is entirely consistent with the hypothesis, but the dates 9.12.9.8.1 on Lintel 25, and 9.13.17.-15.12 on Lintel 24 are outside of the range of the fourth katun, and the ben-ich katun notations that follow them must refer to the dates on the front of these lintels, though it is not altogether clear to me how this reference is indicated in the text.

The most serious contradiction of all occurs on Stela 6, where a date read by Morley as 9.11.3.10.13 5 Ben 1 Zotz is stated to be the second katun anniversary of the inaugural date of the bird-jaguar. This statement cannot be reconciled with the record on Lintels 30 and 31 unless we assume that there were at least two rulers at Yaxchilán with the same or with very similar names.

I do not want to minimize these difficulties, but they do not seem to me to be insurmountable, and they have no real bearing on the general conclusion that if the ben-ich katun notations do place dates in the long count, they must refer to some overlapping system of records analogous to that described for Piedras Negras. That this hypothesis demands a rereading of many of the dates proposed by Morley for the Yaxchilán lintels is all to the good, for Morley's dates are spread over too long a period of time to be consistent with the stylistic uniformity of the sculptures. I am confident that when we understand more about

FIG. 11. The front or "deity" side of Stela 11, Yaxchilán. The figures in the upper panel may be ancestral portraits. Photograph courtesy of the Peabody Museum, Harvard University.

the structure of the jaguar phrases at Yaxchilán, we can reach a satisfactory solution of the problem of the ben-ich katuns.

The first important step is the recognition of the phrases as groups of appellatives referring to the current rulers or to their associates. This historical postulate can only be tested by use, but it seems to me it has already shown many advantages over the view that only religious and astronomical matters are dealt with in Maya texts. For example, neither lunar nor determinant meanings that have been advanced for dates show any correlation whatever with the hieroglyphs that follow date notations or with the sculptured representations on the monuments on which the dates occur. Teeple suggested (1930: 55–7) that the dates, 9.12.2.-0.16 at Piedras Negras, 9.12.10.5.12 at Naranjo, and 9.16.1.0.0 at Yaxchilán, celebrate the change to a lunar calendar. The first is an initial date followed by the upended frog glyph and associated with a female figure. The second also goes with the figure of a woman, but is not an initial date. The third is an inaugural date, associated with the toothache glyph and with figures of men.

The determinant theory also applies indiscriminately to various classes of dates and monuments. Two katun determinants listed by Teeple (1931, Table 7) are inaugural dates: 9.10.6.5.9 from Piedras Negras and 9.16.12.5.17 from Copán. A third date, 11 Lamat 6 Xul, from Palenque, is an initial date, and the class of others is unknown. Thompson (1950, Table 21) lists among determinants for 8 Cumku the inaugural date 9.17.5.8.9 from Bonampak, and this is the only date of its kind that the table contains, the date 9.14.2.11.9 from Piedras Negras being of undetermined character.

All this does not mean that we must abandon the search for astronomical meaning in inscriptions, or that we need to make a categorical choice between the two approaches to the problem of date interpretation. But the astronomical approach has had a long head-start on the historical, which has never been put to the test. Perhaps if we had expended as much time on seeking historical data as has been spent on lunar calculations, we might have collected by now a substantial body of facts on the dynastic structure of the Maya "Old Empire." To be sure, final solution of the import of the texts must probably await the decipherment of hieroglyphs, but we are not yet so close to this achievement that we can afford to neglect other ways of tackling the problem, and the historical approach deserves at least an earnest consideration on our part.

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A NEW DATING METHOD USING OBSIDIAN: PART I, THE DEVELOPMENT OF THE METHOD *

IRVING FRIEDMAN AND ROBERT L. SMITH

ABSTRACT

A freshly exposed surface of obsidian will take up water from the atmosphere to form a hydrated surface layer. This layer has a different density and refractive index than does the remainder of the obsidian. Using special techniques, a thin section of the obsidian cut at right angles to the surface can be prepared. When examined under the microscope the hydrated layer is visible and its thickness can be measured. Photomicrographs of such thin sections are shown. Factors that determine the rate of hydration were considered. Using artifacts from archaeological sites of known age, the influence of temperature, relative humidity, chemical composition of the obsidian, burning and erosion of the obsidian on the rates of hydration was determined. Temperature and chemical composition are the main factors controlling the rate of hydration. Obsidian hydrates more rapidly at a higher temperature, and thus progresses at a faster rate in tropical than in arctic climates. Rhyolitic obsidian hydrates more slowly than does trachytic obsidian. Using archaeological data from various parts of the world, several tentative hydration rates were determined for tropical, temperate, and arctic climates. The method in its present state of development is especially suited to determine relative chronologies in layered sequences of artifacts from a single site, or region. It is also useful for detecting fake artifacts. Future work to refine the method is suggested.

DURING GEOCHEMICAL research on obsidians, certain problems arose that required the use of specimens of known age excavated by archaeologists. As the work continued, there developed, in addition to the geological significance of the problem, sufficient data to suggest that obsidian might be used for the dating of archaeological remains. The investigation is only at its beginning, and there are many problems both of a geochemical and archaeological nature that await solution by future research. Nevertheless, it seems worthwhile to present a paper, based on results of the examination of several hundred thin sections of obsidian artifacts, chips, and flakes from many parts of the world and from a variety of sites ranging from deep stratigraphic deposits of habitation refuse to caches, single finds, and surface collections. The preliminary results of the geological study, the technique of preparing the samples, a discussion of the limitations and problems still inherent in the method, and its possible use by archaeologists for dating, are outlined in this paper. In the following paper, Evans and Meggers, archaeologists who have been familiar with the research from a very early stage of the project, evaluate the method from an archaeological standpoint at its present stage.

THE GEOLOGICAL PROBLEM

During a study of volcanic glasses, Ross and Smith (1955: 1071) observed that all of the naturally formed surfaces on obsidians that they examined had undergone a chemical and physical change known as hydration. From this observation they concluded that many high-water-content volcanic glasses had become hydrated since formation. The water taken up by the obsidian surface had caused an increase in density in this outer layer raising the index of refraction of the hydrated layer, and it also caused the hydrated layer to be mechanically strained. The difference between the index of refraction of the hydrated rim and that of the rest of the obsidian mass, and also the birefringence due to the mechanical strain referred to above (the power of double refraction), make the hydrated layer visible under the microscrope. Continuing the research, Friedman and Smith (1958: 218) demonstrated that the deuterium (heavy hydrogen) content of the water in certain types of hydrated volcanic glass, such as perlite, is comparable to the deuterium content of the surface water (meteoric water) in the same geographic region whereas the deuterium content of the water of associated nonhydrated obsidians was different. This observation favors the theory that hydration of obsidians occurs under normal conditions of atmospheric temperature and pressure on the surface of the earth. The geochemical studies have proved, beyond reasonable doubt, two important points: (1) that obsidians can absorb

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meteoric water to form perlite, and (2) that most perlites contain meteoric water. However, these investigations did not show whether the hydration of the surfaces of the obsidians was a natural and continuing process of geological importance or whether meteoric water was taken in during cooling of the glass or as a result of later hydrothermal alterations.

In order to prove unequivocally that the postulate of hydration of obsidians at atmospheric temperatures and pressures was geologically significant, it was necessary to know if the hydration rate was rapid enough to account for the geologic occurrences of hydrated obsidian. It occurred to us that artifacts of obsidian might represent experiments of long duration under different and known conditions which could not be easily reproduced in a laboratory. Artifacts made of obsidian were shaped by chipping the surfaces and thus a fresh (nonhydrated) face would have been exposed by the makers in the process of manufacture. Then, these artifacts, flakes, and chips would have been buried as grave or ceremonial offerings, or discarded or lost in the refuse of the habitation site. The archaeologist, in reconstructing the history of extinct cultures, assigns ages to the objects he finds by means of relative chronology, seriation techniques, rates of refuse accumulation, historic records, radiocarbon dates, tree-ring dating, calendar correlations of glyphs, and so on. If the age of an obsidian object was known by one of these methods, then the thickness of the hydrated layer, if it existed, could be measured under the microscope and by correlation with the known age, some idea of the rate of hydration could be established.

At this stage of the experiment we did not know how old the artifacts or man-made obsidian chips and flakes had to be to show a measurable rim of hydration so we sought obsidian artifacts in museum collections that belonged to known archaeological complexes that had been dated. The first archaeological specimen (Table 1, 2–1) examined was an obsidian projectile point from Mound No. 11, Ross County, Ohio, of the Hopewell culture, submitted by Donald Collier of the Chicago Natural History Museum, and said to date about 2000 years B.P. The sample showed a hydration rim of 3 microns thickness proving definitely that hydration of obsidian surfaces could take place at the normal atmospheric temperatures and pressures found on the surface of the earth. This result indicated also that hydration was a geologically significant process that continued after the cooling and hardening of the volcanic glass.

With this point proven, the next step was to see if the hydration rim developed at any fixed rate. Again the aid of the archaeologists was sought. Material from successive levels of a deep stratigraphic excavation was needed to determine whether the thickness of the hydration rim decreased consistently from bottom to top of the refuse deposit, as the age of the samples diminished. Such a collection was available at the United States National Museum from the Chorrera site, Los Rios Province, on the south coast of Ecuador, excavated by Clifford Evans and Betty J. Meggers. This site had three distinct cultural occupations in refuse 4 m. deep; the cut had been excavated in 15 cm. levels, and obsidian artifacts, chips, and flakes were recovered in large quantities from each level. At first, several obsidian specimens were examined from three levels: one near the top, another near the middle and another near the bottom of the stratigraphic excavation. The hydration rims of those samples from the bottom or oldest level ranged from 5.2 to 6.7 microns, while those in the middle and top levels were, on the whole, thinner. These results indicated that there was a correlation between depth of hydration of the surface of obsidian and the passage of time, and suggested that it might be possible to establish a rate of development.

The research already undertaken had indicated the presence of certain variables that might alter the rate of "growth" of the hydration rim. To evaluate these, investigation was continued along two lines: (1) geochemical, to seek an understanding of the factors that control the development of the hydration rim; and, (2) archaeological, to see if rates of hydration rim development could be established from dated archaeological specimens. If rates could be determined to be constant, then several important applications were in view. Of primary interest to geology would be the establishment of a method of dating obsidians in different geological environments. Of equal interest, but probably the more feasible of the two, might be the development of a new, rapid, and inexpensive dating method for archaeology.

Techniques for Study of the Hydration Rim

Cutting the Thin Section

A small section of the obsidian artifact, flake, or chip is cut out at right angles to the chipped or worked surface. This section is ground down, examined under the microscope, and the thickness of the hydrated layer is then measured. Since the techniques of making the thin section are rather specialized and are also the key to a successful application of the method to any problem of "dating," they are described in detail.

The section is cut with a thin (0.015 inch thick) continuous-rim diamond cut-off saw blade. Such a blade contains a high concentration of fine diamond powder imbedded in a bonded metal rim and not only makes a thin, clean cut, but also causes a minimum of chipping of the brittle obsidian. The obsidian specimen is held in the hand and pushed against the watercooled, 4-inch diameter saw blade revolving at 3000 rpm. (Fig. 1). This type of saw revolving at this speed allows us to cut through most small obsidian samples in less than 30 seconds. If the object is a small chip or flake, a complete cross section may be cut off. If it is a projectile point or other large artifact that cannot be defaced by making a cross section, a small V-shaped notch is cut into the edge where it will be least conspicuous and will not destroy the exhibit qualities of the artifact.

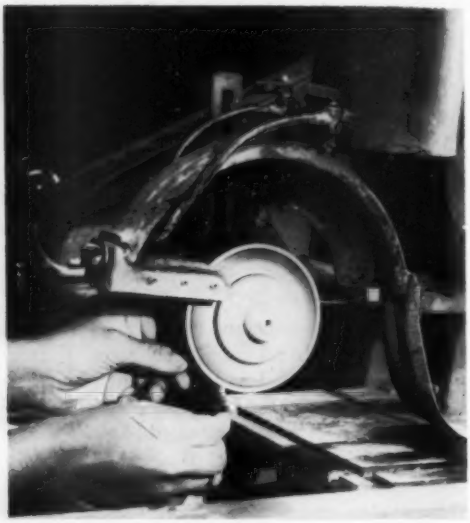

Fig. 1. Cutting a small slice from the obsidian artifact on a water-cooled, diamond-charged saw.

Fig. 2. Initial grinding of the obsidian slice. Cemented on the lower end of the square rod, held in a vertical position, the slice is ground against the horizontal steel lap. A slurry of water and corundum in the porcelain container is fed to the revolving lap with the fingers.

The sawed-out section is then enclosed in and cemented with cooked Canada balsam to a square aluminum rod ½ by ½ by 6 inches long, with the sawed face, which is at right angle to the chipped surface, placed against the rod. The rod and specimen are then held vertically in a V-slotted block-rest above the grinding lap (Fig. 2). We have used a 3¼-inch diameter steel lap revolving at about 400 rpm., continuously charged with a slurry of 303½ corundum powder and water. Very slight pressure is applied to the aluminum rod, and grinding is continued until the obsidian section is about 1/16 to 1/32 inch thick. This ground surface is marked with a pencil for identification. Then the rod is warmed to melt the balsam and the obsidian slice is removed. Next, the thin section of obsidian is cemented to a glass microscope slide with cooked Canada

balsam, so that the marked face is against the glass slide. The slide with the thin section affixed is now held in the hand and the obsidian is ground again on the same lap to approximately 0.010 inch thick. The final grinding to a thickness of 0.002 to 0.003 inch is done on a glass plate using the same abrasive by rubbing the glass slide and affixed section gently back and forth or in a circular motion until the desired thickness is reached. The thin section of obsidian is now completed by covering the specimen with cooked Canada balsam and affixing a cover glass.

With luck and the skill acquired through practice, three to six thin sections can be made per hour and 70% to 90% of the slides will be satisfactory. In order for the slide to be usable, a major portion of the hydrated rim must be retained intact and some of this hydrated rim must have been sectioned at right angles to the surface originally chipped by man. The latter condition can be checked quickly under the microscope. As the microscope is adjusted in and out of focus, the inner edge of the hydrated layer (the point where it contacts the nonhydrated obsidian) should not shift its position if the section has been cut perpendicular to the surface. In a thin section cut at an inclination to the surface instead of right angles, this boundary line will appear to shift to the right or to the left of a fixed reference point on the eyepiece scale as the focus of the microscope is moved from the upper surface to the lower surface of the thin section. Usually an area can be found on the slide where there is no inclination of the hydrated rim. If not, a new thin section of this specimen must be cut and ground.

Measurement of the Hydration Rim

All measurements were made with a 12.5x filar micrometer ocular. A 45x objective was used when the hydration layers were more

FIG. 3. Photomicrograph of a thin section of an obsidian artifact showing the hydration layer as viewed in ordinary light.

FIG. 4. Photomicrograph of the specimen shown in Figure 3 viewed under crossed polarized light. The hydrated layer is bright because of strain birefringence.

than 2.0 microns thick; a 100x oil immersion apochromatic objective was used to measure layers thinner than 2.0 microns. With the 45x objective, a single division on the filar micrometer ocular drum corresponds on our petrographic microscope to 0.11 micron, while with the 100x objective one division on the drum equals 0.049 micron.

Identification of the boundary line of the hydration rim takes only a little practice and experience. The hydrated rim may be viewed either in transmitted ordinary light (Fig. 3) or under crossed polarized light (Fig. 4). The feature of birefringence of the hydration rim due to the strain in the layer causes the layer of hydration to appear bright under crossed polarized light. This birefringence may be an aid in detecting the presence of the hydration rim in some obsidians, but the measurement must be made in plain light. Gross differences in thickness are easily distinguished, as is evident from a comparison of a photomicrograph of a hydrated layer 15 microns thick (Fig. 5) with one 1.5 microns thick (Fig. 6). In both examples, the obsidian has been labeled, and the Canadian balsam mounting medium is the unlabeled portion. Another photomicrograph that demonstrates the ease of distinguishing different thickness of hydration is shown in Figure 7. This specimen comes from one of the Chorrera period refuse layers of the Chorrera site on coastal Ecuador and was a core

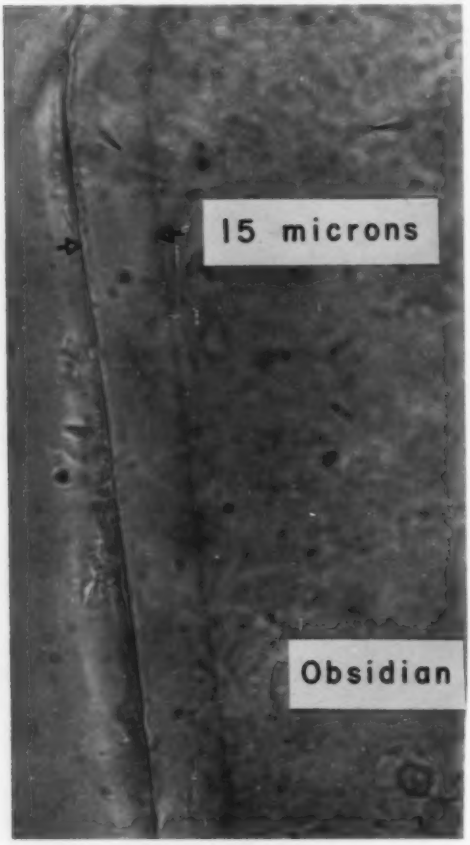

Fig. 5. Photomicrograph of a thin section of an obsidian artifact with a thick hydration layer viewed in ordinary light.

Fig. 6. Photomicrograph of a thin section of an obsidian artifact with a thin hydration layer viewed in ordinary light.

fragment from which the worker had struck several flakes to make flake scrapers. In striking the core, most of the old, original surfaces of the obsidian were removed, but in a few places they were missed. Percussion cracks also penetrated the obsidian core. The hydration rim of 28 microns measures an original surface of this obsidian before man chipped the surface; the 6 micron thickness along the cracks is the same thickness as the remainder of the worked face of the artifact and agrees well with the thickness of hydration of other artifacts from the same cultural level.

Since one of the potentially variable factors in the use of obsidian for dating is the precision with which the rim can be measured, the following procedure was adopted to minimize the bias in the measurements:

1. One of us, the observer, looks into the microscope, and the other, the recorder, reads the filar micrometer ocular drum.

2. The observer moves the filar micrometer ocular hairline to one edge of the hydration rim and signals to the recorder. The recorder writes down the ocular drum reading. The observer then moves the hairline to the other edge of the hydration rim and again signals the recorder, who again writes down the ocular drum reading. The difference in these two readings is then taken. The observer repeats this procedure, measuring exactly the same place, and the recorder writes down the new measurements. The observer then chooses two other different, suitable locations on the slide and measures each in duplicate, and the recorder copies down all the readings on the ocular drum. During all these measurements, the observer continues to look into the microscope and does not know the results of any of his measurements on the same specimen.

3. The observer and the recorder then change places and three different areas are measured, each in duplicate, while the measurements again are written down by the recorder without the observer having any knowledge of the results.

4. All measurements were made by moving the micrometer screw in the same direction so that "backlash" or lost motion in the screw would not be a factor.

With few exceptions on several hundred slides, the individual measurements made by a single observer agreed within a sigma of 0.1 micron, and agreement between the average measurements of two observers is within a sigma of 0.2 micron. Converted into simpler terms, this means that about 68 out of 100 measurements will not deviate more than 0.1 micron due to the errors of measurement by a single observer, and not more than 0.2 micron due to the errors of measurement between two observers. In several cases more than one thin section was made of the same specimen and all were measured. The results of these measurements agree within a sigma of 0.11 micron. Stated differently, about 68 out of 100 measurements will not deviate more than 0.11 micron due to errors of measurement between different thin sections from the same specimen.

Factors Affecting the Rate of Hydration

The validity of utilizing measurement of hydration rims of obsidian as a basis for dating depends entirely on the constancy of the hy-

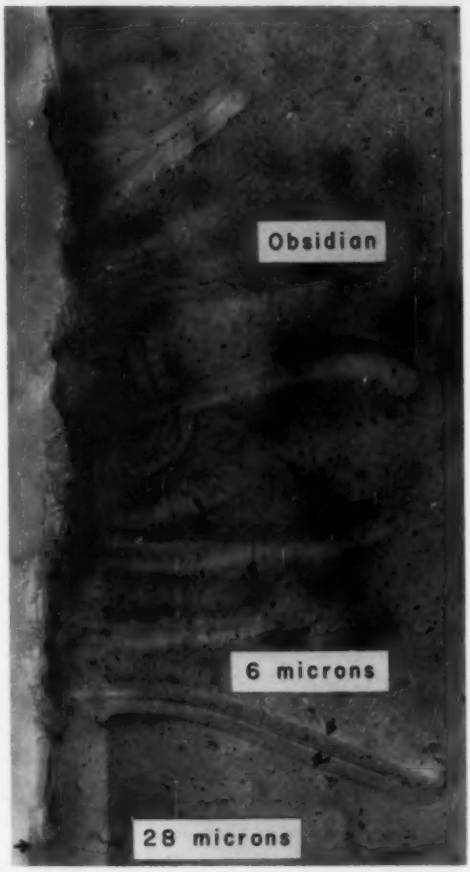

FIG. 7. Photomicrograph of a thin section of an obsidian artifact from Ecuador showing a thick hydration layer along an original, unworked surface (lower left); adjacent to a flaked area. Blows struck on the artifact introduced a series of short percussion cracks. The thickness of the hydration layer formed along these cracks is the same as on the remainder of the worked surfaces of the artifact.

dration rate on the surface of the obsidian. Therefore, any variable that can affect this rate must be investigated and assessed. The following factors must be considered:

Relative Humidity

Early in this research we had predicted upon theoretical grounds that the relative humidity in the environment was not an important variable. Subsequent measurements, correlation with the dates given by the archaeologists for the various specimens, and an evaluation of these data in terms of the temperature and humidity of the environment strengthen this original assumption. The theoretical inference is based upon the fact that the rate of any diffusion process is determined by the concentration gradient by which the material diffuses. If our analysis of the hydration process of obsidian is correct, the concentration gradient across the diffusion front (Fig. 8) is constant and independent of the relative humidity in either the soil or air environment surrounding the specimen. We believe that the surface of obsidian takes on water by chemical adsorption much as silica gel adsorbs water. The surface of obsidian has a strong affinity for water as is shown by the fact that the vapor pressure of the water over the obsidian surface is extremely low (in the order of 10^{-5} mm. of Hg). This process of adsorption continues until the surface is saturated with a layer of water molecules. Then, the rate-determining process is the slow diffusion of these water molecules into the body of the obsidian. Examination of the water content of obsidians and perlites indicates that most obsidians contain from 0.1% to 0.3% water whereas most perlites contain about 3.5% water. Thus, on a fresh piece of obsidian struck from the center of a large mass the water content is, for most obsidians, about 0.1% to 0.3%. On the surfaces of obsidians that show hydration, the water content of this hydrated layer never exceeds about 3.5%. This means that about 3.5% water content is the "end state" or "saturation point" of the sorption of the water by obsidian at atmospheric temperature and pressure.

In many substances diffusion fronts are sloping or gradational. However, in obsidians this diffusion front is sharp, varying only in the order of 0.1 micron in depth. Examination of Figure 8 will make this explanation clearer. On this graph, the percent of water is plotted vertically, and the depth from the surface in microns is plotted horizontally. A specimen that has a hydration layer 1.5 microns thick is "saturated" with about 3.5% water to this depth. Beyond it the nonhydrated mass of obsidian has a water content of only 0.1% to 0.3%.

If this analysis of the process of adsorption of water and its diffusion into the obsidian is correct, humidity will not be an important variable factor in determining the rate of hydration. This explains why the same rate appears to prevail in regions of similar mean annual temperature, but with considerable differences in humidity. Samples from the dry Danger Cave, Utah, have hydrated at the same rate as those buried in moist soils in Ohio, while some obsidian objects from Egyptian tombs hydrate at a rate only slightly lower than artifacts buried in the moist tropical soils of coastal Ecuador.

Temperature

The rate of any diffusion process can be expected to be in large part dependent on temperature. Research on the problem of hydration of obsidian shows that this is a very important variable. Artifacts from Alaska, found in permanently frozen ground and dated by radiocarbon, hydrated at a much slower rate than did artifacts of the same age from temperate or tropical regions (the rate is 0.36 micron^2/1000 years for northern Alaska compared to 11 microns^2/1000 years for the tropics). Hence the width of the hydration rims for the specimens from Alaska was considerably less than on specimens of equal age from temperate or tropical regions. Even within the Alaska area, there are local differences in mean annual temperatures that must be considered; for example, artifacts from northern Alaska hydrate at a slower rate than those buried in southeastern Alaska, where the temperature is considerably moderated by the Japanese current. Further research work on this point will no doubt show that specimens from the same region but from different temperature zones, such as highland Ecuador versus lowland, coastal Ecuador and the high plateau versus the desert sites of the American Southwest, will show different hydration rates.

The possibility of different temperature of exposure exists also within a single climatic zone. Because of its heat absorbing black color, a piece of obsidian lying on the surface may experience temperatures much higher than one buried in the ground. The contrast is likely to

be most pronounced in deserts where a minimum cover of vegetation exists and artifacts may be exposed to the sun for great lengths of time. Under such conditions, the rate of hydration would be increased producing a thick rim in a relatively short time. This might be the explanation for the unusually thick hydration rims for the Death Valley, California, material, all of which came from surface collections (Table 1, 5–1, 5–2). Consequently, in correlating data from site to site, or from area to area, or from surface collections to deeply buried specimens, the temperature factor must be kept in mind.

Detailed studies of soil temperatures are needed to understand the influence of the temperature variation upon the rate because the mean annual air temperature rates in some regions give only an approximate indication of the actual temperatures to which obsidian arti-

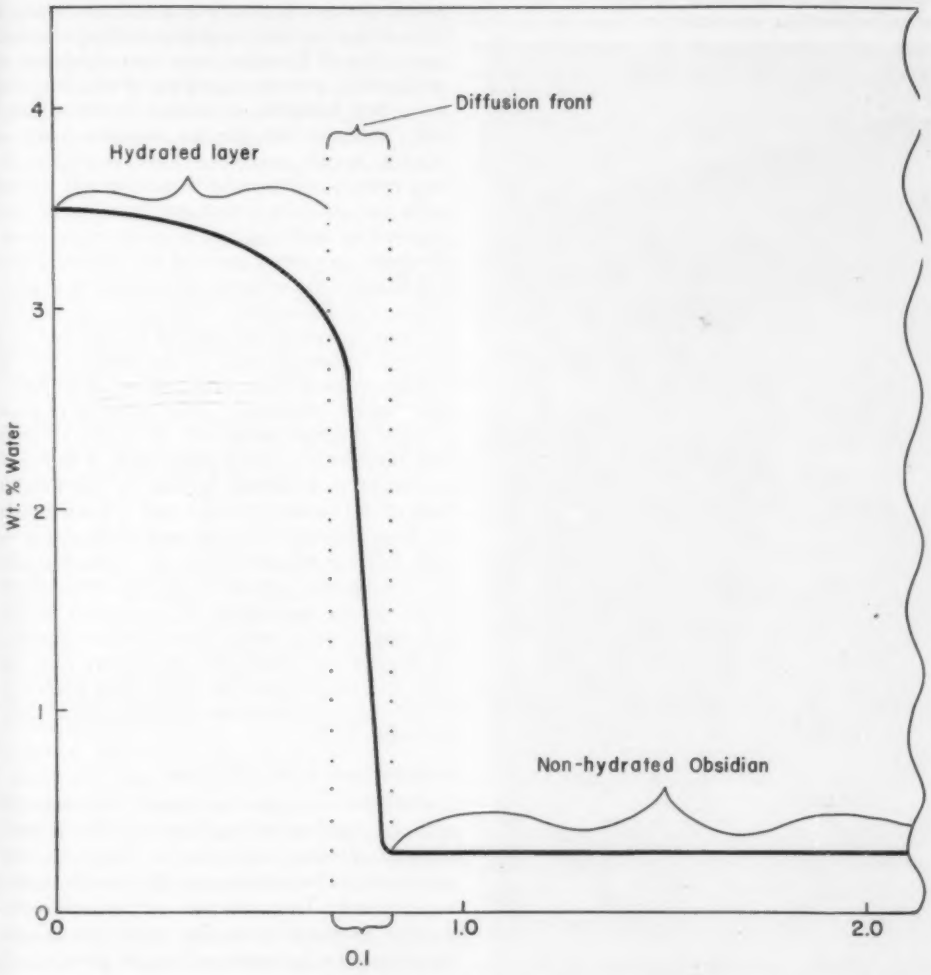

FIG. 8. Schematic diagram of the cross section of an obsidian artifact showing the high water content of the "saturated" hydration layer, the narrow and nearly vertical diffusion front, and the low water content of the non-hydrated obsidian.

facts were subjected while buried in different kinds of soils and at different depths, as has been shown by Chang (1957) and others.

Laboratory experiments are now in progress to investigate hydration rates at elevated temperatures. If it is possible to determine the temperature coefficient of the hydration process experimentally, then some of the problems now arising in the evaluation of archaeological specimens may be solved. If this experimental work is successful then it would be useful to take the actual subsurface temperatures of archaeological sites and to determine the best estimates of the possible changes of ground temperature due to gross climatic shifts during the period of occupancy of the site. Then we would have data to demonstrate if temperature is actually the main factor in the hydration rate of obsidian or if other factors not now fully understood are also important in changing this rate.

Fig. 9. Surface of an obsidian artifact magnified to show the cross hatched pattern of the surface cracks that sometimes results from burning. Specimens having this appearance are not suitable for measurement because burning has altered the surface and affected the hydration.

Since temperature seems to be such an important factor in the rate of formation of the hydration layer (Fig. 17), the establishment of an areal rate requires the assumption that climate has been relatively constant over a long period of time. It can be assumed that artifacts from sites close to the equator, such as the lowland coast of Ecuador, have been subjected to similar temperatures regardless of whether they are a few hundred or several thousand years old. In areas like the far northern parts of Alaska, arctic conditions have prevailed for long periods of time and there does not appear to be any indication that specimens were ever exposed to anything but a cold temperature. However, in certain parts of the United States and Europe, the advance and retreat of glaciers during the Pleistocene produced a gross temperature variation that should be reflected in a varying hydration rate if the artifact is old enough to have been subjected to these different climatic conditions. This problem of gross changes in temperature over thousands of years will affect only a small proportion of the total specimens to be dated because at the present state of the research project only a few artifacts are from deposits that are accurately dated as tens of thousands years old. All of the samples so far examined appear to fit the curves established on the assumption of a constant hydration rate. Further research may make it possible to develop an integrated hydration rate for objects of greater age that might have been subjected to gross variations in mean annual temperature.

Composition of the Obsidian

Obsidian is a glass composed of a mixture of some eight major components, plus a great number of minor components. There is some variation in the proportions of even the major components. The variation within one petrographic province is usually small, but greater variation can be expected from province to province. Although non-geologists often think of obsidians as only black, one should note that they range from clear to gray to black with all variations of reddish-browns to reddish-blacks

and with all degrees of banding or mottling. All these differences are due to differences in chemical composition or to physical properties relative to cooling. Obsidians of different compositions may have different rates of hydration and a different temperature coefficient of the rate of hydration. Only the continued testing of a wide variety of specimens from all over the world will make it possible to assess this problem. Fortunately, the great bulk of obsidians are rhyolitic in composition regardless of color. However, some indication of the effect a difference in composition may have can be seen by a comparison of the various Egyptian samples. Four of these (Table 1, 15–1, 15–2, 15–3a, 15–5) are a variety called trachytic obsidian, which is different chemically from the North American, South American, and Japanese obsidians. The Egyptian trachytic obsidian is quite brown (not all brown obsidians are trachytic) in thin section, and appears to be a low silica, high iron, high soda content obsidian that hydrates at a much faster rate than other obsidians. Unfortunately, the archaeological specimens could not be ground up to make a chemical analysis. The more "normal" or "typical" obsidian from Egypt (Table 1, 15–6, 15–38), termed "rhyolitic" obsidian on the graphs, hydrates at a rate that is not greatly different from obsidians of coastal Ecuador.

Burning

Exposure of the obsidian artifacts, flakes, or chips to fire, such as cremation, ceremonial burning, or accidental exposure to hearths, alters the surfaces and affects the hydration after burning. Usually burning can be easily distinguished by a careful examination of the obsidian artifact because the surface appears abnormally gray, and a fine pattern of cross-hatched cracks is visible to the naked eye or under 10x magnification (Fig. 9). Some specimens have a slaggy or bubbly surface showing the effects of melting. In addition to these differences visible on the surfaces, other physical characteristics change and are readily distinguishable in the thin sections. The photomicrograph (Fig. 10) of a thin section cut at right angles to a burned surface shows two features distinct from thin sections of unburned obsidian (compare Figs. 3–6). An irregular, "scalloped" interface appears between the hydrated layer and the non-hydrated part of the obsidian, and the cross-hatched cracks visible on the surface extend inward as long or short, wavy or straight lines.

The chemical or physical cause of the observed effects of burning on obsidian is not completely understood at present. One possible explanation is that the diffusion of alkali and alkaline earth oxides from the hot wood ashes into the obsidian surface may produce a change in volume, and thus cause stress and subsequent cracking. Regardless of the mechan-

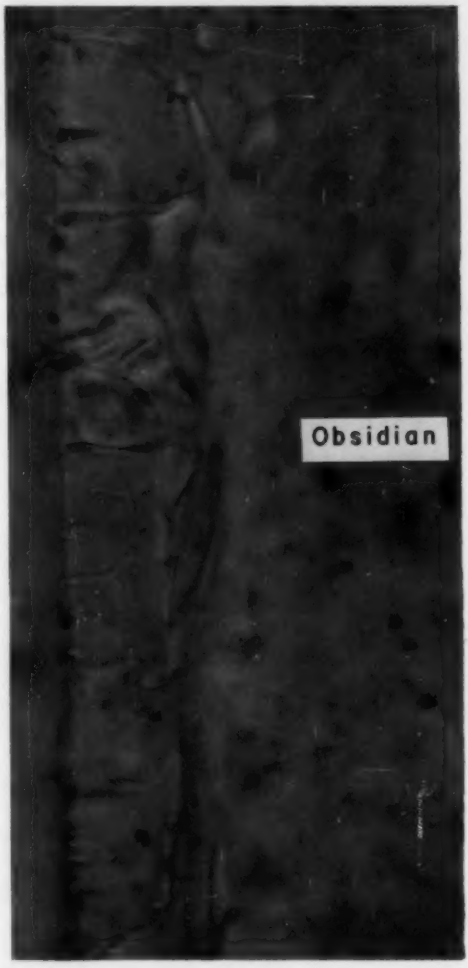

FIG. 10. Photomicrograph of a thin section of a burned obsidian artifact. Note how the inner edge of the hydration layer is irregular rather than parallel to the surface.

ics of the effect, artifacts showing burning cannot be used at this stage of development of this study.

Erosion

Either chemical or mechanical erosion can remove the relatively thin hydration layer. So far no example of chemical erosion has been identified. However, mechanical erosion takes several forms, such as blasting by wind-blown sand, and abrasion in water carrying large amounts of mud or sand. Erosion of the hydration layer is evident on some of the obsidian artifacts sent by L. S. B. Leakey from East Africa, estimated from geological evidence to be of the Middle to Late Pleistocene age. Many of these artifacts show the obvious effects of erosion with the surfaces abraded and the corners rounded. The hydration rim on such specimens is thin whereas other artifacts from the same culture show a much thicker rim, measuring 20.2 to 28.2 microns (Table 1, 30–2a, 30–2d, 40–3d). If the original, thicker hydration rim is eroded away, subsequent hydration will cause a new hydration layer to develop if the factors causing erosion are removed. When the original surface of the artifact has been sand blasted, not only is the original thick hydration rim removed but little pits or chipped-out places are left on the surface, which contrast with the smooth, concoidally-fractured surfaces so typical of obsidians. Microscopic examination of a thin section of this surface shows it to be distinct from that of uneroded obsidian. The photomicrograph of a thin section of such an artifact (Fig. 11) shows a thin hydration layer that is irregular and pitted, conforming to the abraded surface.

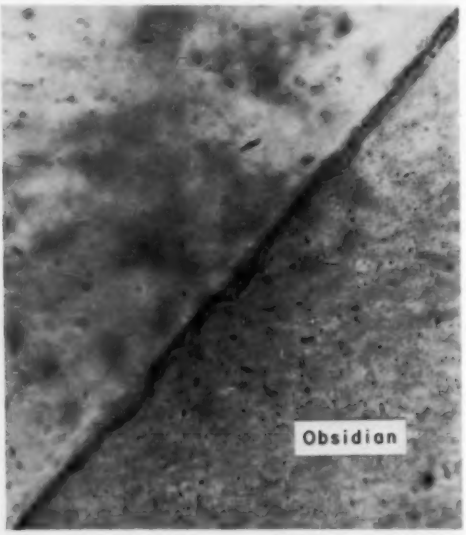

Fig. 11. Photomicrograph of a thin section of an obsidian artifact that suffered intense abrasion, such as sand blasting in a windy, arid environment, and subsequently hydrated. The thickness of the hydration layer indicates that approximately 300 years have elapsed since the abrasion occurred.

Establishment of Rates of Hydration Using Dated Archaeological Specimens

In order to establish an easy method of presenting the data graphically, we constructed a chart in which the horizontal element is "time before present expressed in years" and the vertical element is the "hydrated rim thickness in microns squared." This type of plot was chosen because many diffusional effects give a straight line when the time is plotted against the square of the diffused distance, indicating that the rate of increase of the hydrated layer is inversely proportional to the thickness of the layer (Quadratic Law of Tammann). The data from archaeological samples from the same site or at least the same region were put on a single chart. When materials from another area were measured, separate charts were made. For example, first a chart was made of all the samples from the deep stratigraphic cut of Chorrera, Guayas Province, coastal Ecuador; other charts were made of the samples from Shanidar Cave, Iraq, the Arctic archaeological specimens from Alaska, the samples from the southwestern United States, and so on.

In order to plot the data on each chart, the hydration rim thickness in microns squared and a dependable date were needed for each specimen. The archaeologists had given dates when they had submitted their samples, having derived these from correlations with archaeological complexes, or from radiocarbon, geochronological estimates, tree-ring dates, or historic information. Sometimes it was necessary for us to take into account the probable reliability of the "actual" date when the information was given in gross terms spanning long periods of time. At times these data were rectified by correspondence or discussion with the archaeologists; at other times we were the ones who had to make the final adjustment.

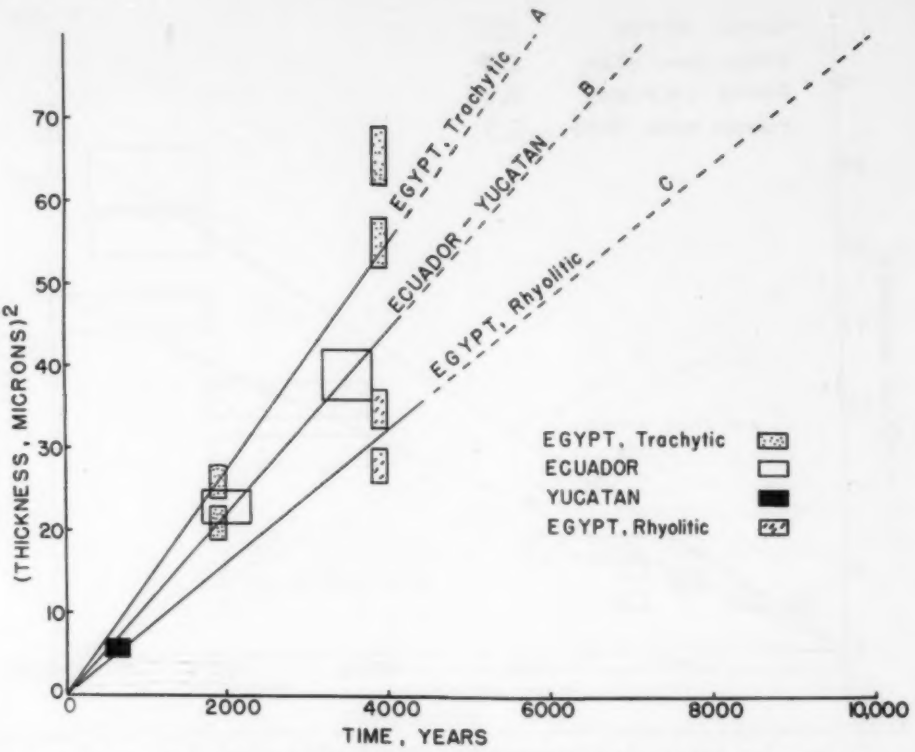

FIG. 12. Diagram showing the thickness of the hydration layer in microns squared on objects of known age from sites in tropical zones to arrive at hydration rates for these areas (Scales A, B, and C).

The assigned age of each sample was plotted against the thickness of the rim in microns squared, using a margin of error of 0.2 micron squared to allow for the "error in measurement" of the thickness of the hydration rim. As soon as a few relatively reliable reference points were established on each chart, it was then possible to draw a straight line connecting these points, which thus established a tentative rate of hydration for a given climatic zone. In all cases the data appear to follow a series of lines, one each for the two types of obsidian from Egypt, another for the lowland coastal Ecuador specimens, two lines for the arctic specimens, and two for the samples from temperate climates. When data are available from other climatic zones, additional lines can be drawn to represent different rates of hydration.

Once these hydration curves or rates expressed by the slope of straight lines on the charts are established, the thickness of the hydration rim of a specimen without correlative dating from other evidence can be measured, the micron thickness squared and the date read off the hydration rate line on the chart. This is the ultimate aim of the research project and we feel confident that the hydration rates can be extrapolated to several hundred thousand years, in some climates, assuming a constant rate of hydration. The upper limit of dating is determined by factors that might alter the constant rate of hydration as well as the limit of the width of the hydration layer. Due to the fact the hydrated layer is under strain, after it reaches a thickness of the order of 40 to 60 microns it tends to spall off and hydration will begin on the new surface.

A brief explanation of the various charts will help in understanding the basis for establishing the various hydration rates.

Figure 12 shows the results of samples from hot tropical climates. The Yucatecan samples

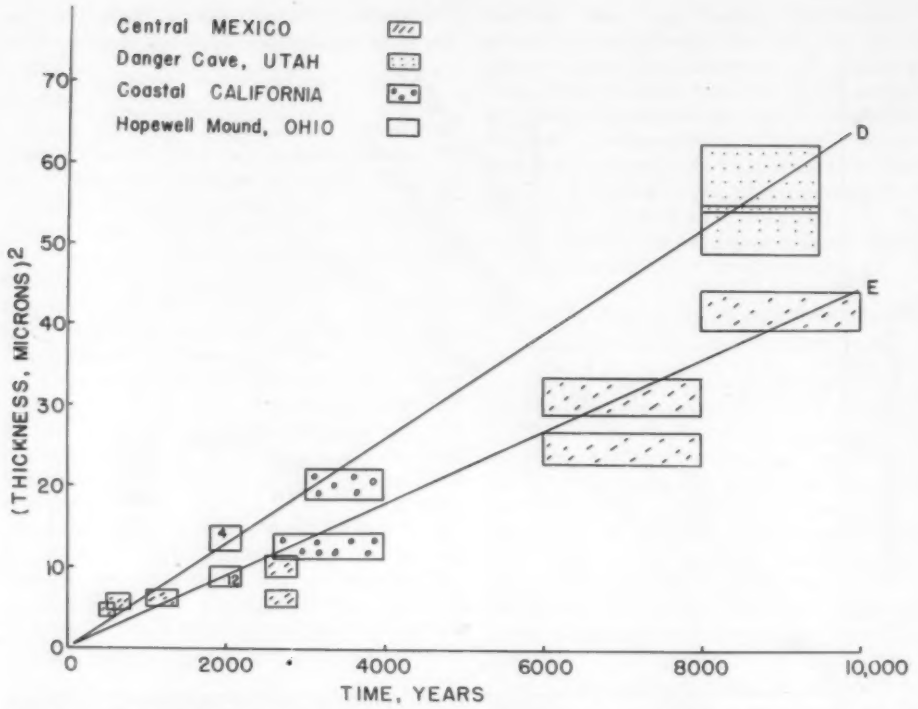

Fig. 13. Diagram showing the thickness of the hydration layer in microns squared on objects of known age from sites in temperate zones (Scales D and E).

(Table 1, 3–1a, 3–1b) are from Mayapán with dates of 450–750 years B.P. The Egyptian artifacts (Table 1, 15–2 through 15–6; 44–2, 44–3) are dated both historically and by radiocarbon. The dating of the lowland coastal Ecuador samples (Table 1, 1–2 through 1–27, 27–1 through 27–17, 28–1 through 28–20; 29–1 through 29–15, 39–1, 39–2a, b) is based on radiocarbon dating of several of the later cultures and an estimated date of 3400 years B.P. given by Evans and Meggers for the beginning of the Chorrera period based on the radiocarbon dating of 4000–4500 years B.P. of certain levels of the preceding occupation, the Valdivia culture.

Figure 13 gives the results for the temperate climates. The dates of the Valley of Mexico samples (Table 1, 22–1, 23–1 through 23–6) are estimates given by Ignacio Bernal based on historical data about the Aztec period, and cultural associations and relationships with other horizons dated by radiocarbon. The dates for the samples from Danger Cave, Utah (Table 1, 4–1a, b) and Hopewell Mound, Ohio (Table 1, 2–1a through 2–3k) are derived from radiocarbon. The central coastal California samples (Table 1, 38–1 through 38–3) are dated by comparative materials of known archaeological horizons and by radiocarbon. Two separate lines were drawn to indicate the range of hydration rates that the temperature climate covers. A refinement of the mean temperature data, especially when detailed information about soil temperatures is available, may make it possible to establish a more exact rate.

Figure 14 is an extension of the data of the two temperate scales of Figure 13 to 40,000 years by reducing the scale of the chart to permit the inclusion of the Shanidar Cave specimens (Table 1, 6–1 through 6–19). Solecki stated that Shanidar Cave had horizons with obsidian that are dated at 12,000 years B.P. and from 27,000 to 32,000 years B.P. by radiocarbon. A newer radiocarbon date from one of the older Shanidar horizons has gone back as far as 45,000 years B.P., but no obsidian artifacts are available from this cultural layer. Although there is a

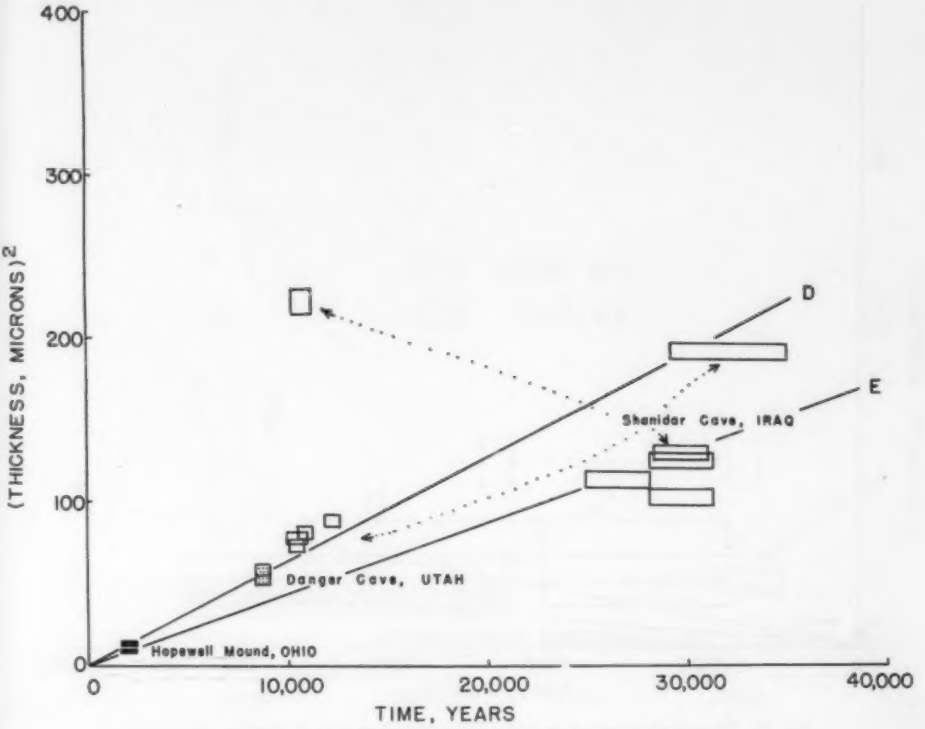

FIG. 14. Projection of hydration rates D and E to reach 40,000 years ago.

variety of thicknesses of hydration rims from the site, we have plotted the thinnest hydration rim as 12,000 years B.P. and the thickest group as 27,000 to 32,000 years B.P.

Figure 15 expresses the two hydration rates for the arctic and subarctic regions. The subarctic points of reference came from estimated dates given by R. S. MacNeish based on soil studies and volcanic eruptions, and a stratigraphic and cultural sequence of the archaeological samples from various sites in south Alaska (Table 1, 20–5 through 20–17). The arctic rate was established by plotting J. L. Giddings' guess dates of 4500–8500 years B.P. for the Denbigh Flint complex samples (Table 1, 7–3a through 7–3e, 20–1 through 20–4).

Figure 16 is a plot of the ages of the samples from the southwestern United States versus the thickness in microns squared of the hydration rims. Dotted lines (rates D and E) are used to show the two rates that should apply by analogy to other regions with similar mean annual temperatures. The dates are scattered and do not check out. It seems probable that the wide climatic variation between mountain and desert environments offers a partial explanation. Further research is needed on a larger number of dated specimens from the Southwest to seek an explanation for these discrepancies. All the samples plotted (Table 1, 8–1, 16–1 through 16–3b, 17–1 through 17–3d, 24–1 through 24–8, 33–1 through 33–11) had dates derived from radiocarbon, or tree-rings.

Figure 17 is a resume of the information shown on Figures 12–15, to present all the hydration rates on one chart for easy reference.

OBSERVATIONS AND CONCLUSIONS

The correlation of archaeological dates with obsidian dates and the value of the hydration rate of obsidian as a possible dating method, are discussed in detail in the next paper by Evans and Meggers. We would like to present some additional observations from a purely geological standpoint and as the result of our

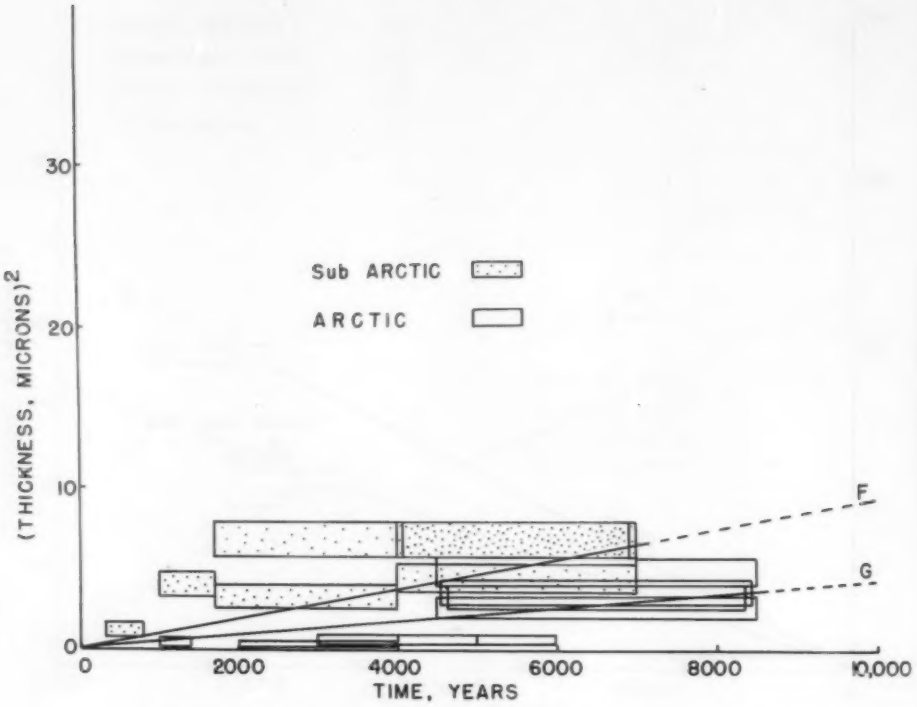

Fig. 15. Diagram showing the thickness of the hydration layer in microns squared on objects of "known" age from sites in arctic and subarctic zones (Rates F and G).

experience in handling a large quantity of obsidian samples. The knowledge that obsidians hydrate after the cooling of the original mass is of geological significance. An effort to discover what factors are variable and may affect the rate of hydration has been fairly successful so far in eliminating relative humidity, and identifying temperature and composition as the main factors in controlling the hydration rates. Evidence of mechanical altering of the surface by fire or erosion must be watched for, since these situations make the obsidian useless for this study. Many research problems still require further investigation. Two of the most important are determination of soil temperatures and compositional differences in various types of obsidians.

A few comments on some of our problems may help orient future research. In developing the rates of hydration, a single sample from a site is not enough. We need a greater quantity of specimens especially from a single cultural complex, level in a stratigraphic excavation, floor of a house, and so on. We need samples that have been collected without any selection; by this we mean the saving of all obsidian chips and flakes as well as artifacts from whatever excavation the archaeologist is making. One of the main reasons the obsidian dating technique appears to work so well for the lowland coast of Ecuador is that we have hundreds of specimens from successive levels of habitation refuse at many sites. Some of these specimens were chips and flakes as small as 5 mm. across, but they all proved useful. The large sample helped work out the problem of re-use of obsidian by later cultures occupying a site with an earlier occupation or "migration" of objects in refuse from scuffling, rodent action, and other factors. As with other systems of dating, it is dangerous to "date" a site from a single specimen because of the possibility of accidental association or re-use. Our plea for larger samples from each cultural horizon at a site can-

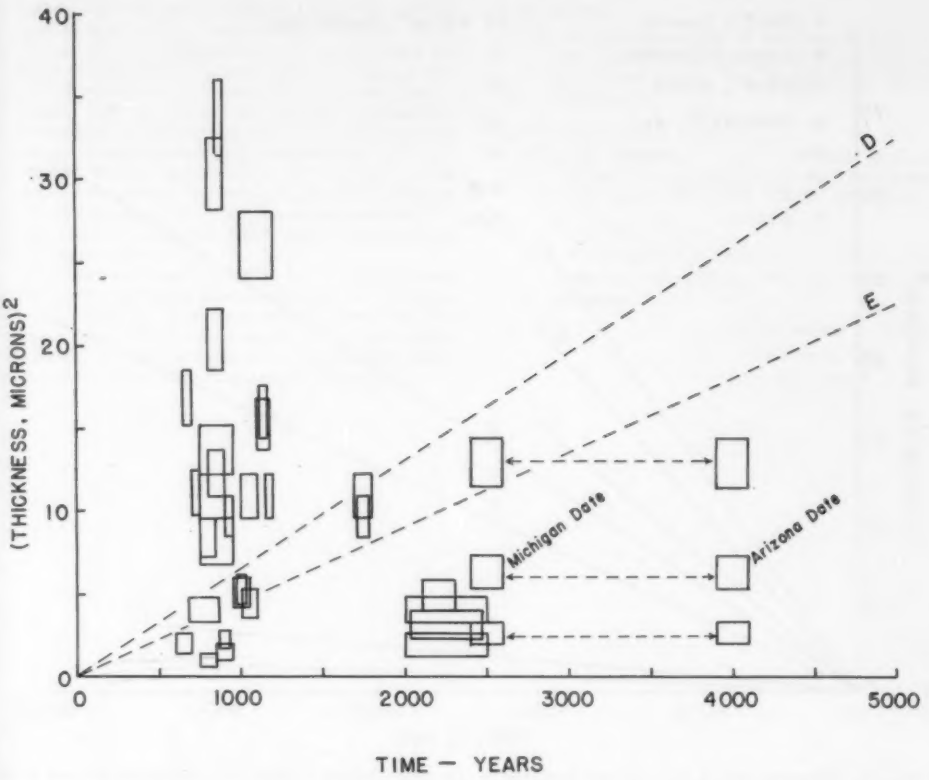

FIG. 16. Diagram showing the thickness of the hydration layer in microns squared on objects of known age from sites in the southwestern United States to determine hydration rates. The scattering of the samples cannot be explained at present. The dotted lines represent the hydration rates D and E, which were established for the temperate zone and should apply to the majority of these artifacts.

not be made too strongly; archaeologists are urged to save everything in the future that even remotely resembles obsidian.

One very significant discovery of this preliminary research is the demonstration that objects of recent manufacture can be detected easily. Since a measurable hydration rim (about 0.5 micron) develops in about 50 years in a temperate climate and in about 30 years in a tropical climate, a very thin or nonexistent rim on a specimen from these areas suggests, at the present stage of our knowledge, recent manufacture. In the case of several Mexican objects (Table 1, 22–2, 23–7) known to be modern, the lack of antiquity was verified by the fact that no hydration rim had developed. Several Maya samples (Table 1, 35–2, 18–2, 18–4, 18–5, 18–6, 18–7) gave very thin hydration rims and our original reaction was that these objects might be of more recent manufacture than the archaeologists believed. A check with the archaeologists presents data that make it hard to assess the thin hydration rims of the Maya specimens in the light of our present knowledge of the development of hydration rims, but we must leave the question open pending further research on our part and possibly a further consideration of the matter by the Mayan specialists themselves.

As geologists we are quite aware of the enthusiasm that scientists have shown when "absolute" dating was made possible in geology and archaeology by means of radiocarbon; however, we must caution that radiocarbon dates are only useful in both geology and archaeology when it is clearly understood just what the

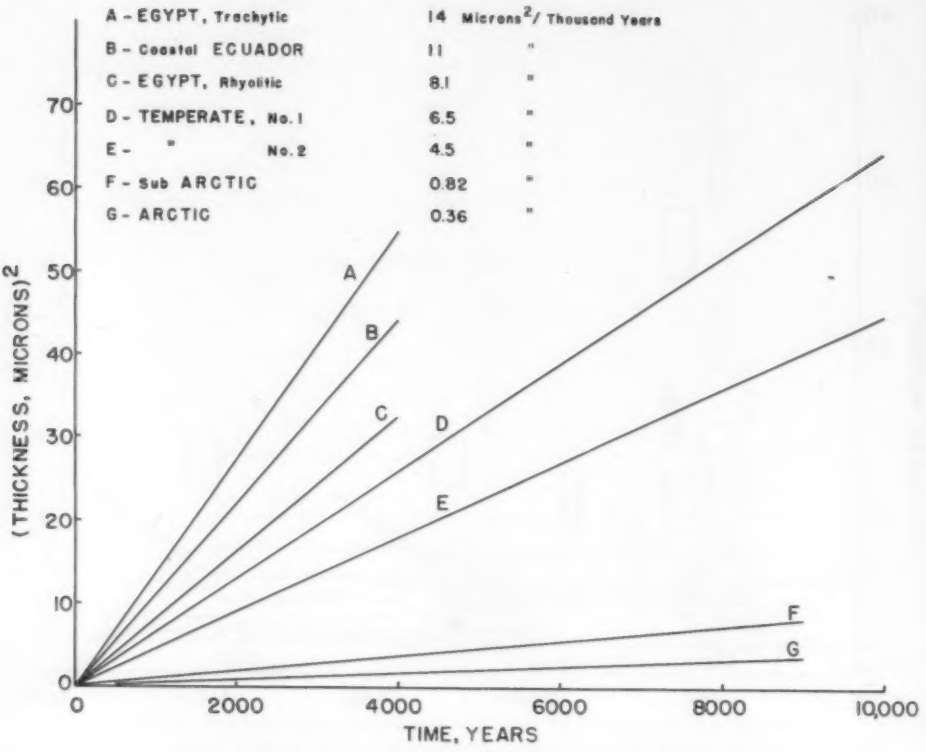

Fig. 17. Hydration rates A, B, C, D, and E plotted on the same diagram to show the variation in the rate in different climatic regions. The rate of hydration of each scale is also stated as a mathematical expression of the slope of the corresponding line.

dates are dating. In archaeology a radiocarbon date may well be valid for the material used in dating, such as ash from a hearth, organic materials from a particular cultural layer, or a house beam in a pueblo ruin, but whether this date actually applies to the artifacts is a point that must be assessed carefully by the archaeologists. Radiocarbon dating itself also has sample contamination errors, both positive ones produced by the inclusion of recent organic remains such as fine rootlets, and negative ones caused by the presence of dead carbonates, and so forth. Therefore, when the obsidian hydration rim dating gives one "absolute" date, radiocarbon another, ceramics or tree-rings dates another (Table 1, 16–1, 17–1, 17–2), as scientists we should not abandon any one or all of the methods for lack of conformity. Each contributor to the problem of devising systems of dating must review the data and see if there is a logical explanation for the discrepancies. This is the reason why we decided to publish this preliminary article and allow geologists and archaeologists a chance to review the data and the method as they now stand with a clear understanding that various problems are still to be investigated and can only be solved by the continued full cooperation of archaeologists and geologists.

It is not for us to dictate the future use of this technique, but in order to evaluate with best results the hydration rates and the influence of the several variables on these rates, it would be desirable if future measurements were made in a central laboratory, or perhaps a few closely cooperating laboratories.

Acknowledgments. Friedman, Smith, Evans, and Meggers express their appreciation to Gustav A. Cooper, Head Curator, Department of Geology, U.S. National Museum, for his encouragement of the research project and for permitting Grover C. Moreland, Physical Science

Aid of the Division of Mineralogy and Petrology, to make thin sections of many of the obsidian artifacts. Moreland's careful and conscientious work has permitted the research to continue at a more rapid rate than would have been possible if all the sectioning had to be done by Friedman. His cooperation and interest are gratefully acknowledged. A debt is also due to Rita Friedman for the many evenings that she spent assisting with the measurements. We are also grateful to Meyer Rubin of the Low Level Radiation Laboratory, U.S. Geological Survey, for providing radiocarbon dates for several samples from archaeological contexts from which obsidian samples were also being measured.

To all those archaeologists who have generously contributed and continue to provide their artifacts for study, we offer thanks for their cooperation and patience. We hope that the results of the research project will eventually permit the establishment of a dating method sufficiently reliable to provide a more tangible reward.

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U.S. GEOLOGICAL SURVEY
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October, 1959

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS.

This table has been assembled by Friedman, Smith, Evans, and Meggers from the provenience information and estimated dates given by the contributors and data derived from the obsidian analysis. All ages have been converted into years (B.P.) Before Present (A.D. 1900–60). The obsidian dates were computed from the thickness of the hydration layer using the rate indicated in parentheses following the ages and rounded off to two significant figures. It must be emphasized that these dates are *tentative approximations*. The fact that the age is given in years does not mean it is "absolute" in the same sense as a historical, calendar date. Where a sample was used as a reference point to establish one of the rates of hydration, this has been indicated in the remarks. The samples are arranged by geographical region, according to the following list:

Alaska — Samples 7–1 through 7–3; 20–1 through 20–17; 37–1.
California — Samples 5–1 through 5–2; 38–1 through 38–2.
Coastal Guatemala — Samples 45–1 through 45–17.
East Africa — Samples 30–1 through 32–2; 40–1 through 41–2.
Ecuador — Samples 1–2 through 1–27; 27–1 through 29–15; 39–1 through 39–2.
Egypt — Samples 15–1 through 15–6; 44–1 through 44–11.
Japan — Samples 48–1 through 48–7.
Maya Area: Yucatán — Samples 3–1.
Guatemala — Samples 18–1 through 18–7; 34–1 through 34–17; 35–1 through 35–2.
Mexico: Chiapas — Samples 47–4 through 47–6.
Valley of Mexico — Samples 22–1 through 23–7.
Near East — Samples 6–2 through 6–19; 11–1 through 11–9; 11–20 through 12–12; 42–1 through 43–2; 13–1 through 13–16.
Ohio — Samples 2–1 through 2–7.
Oregon — Samples 51–1 through 51–6.
Southwestern United States: Arizona — Samples 16–1 through 17–3.
Colorado — Samples 9–1 through 9–3; 24–1 through 24–8.
New Mexico — Samples 8–1; 33–1 through 33–11.
Utah — Samples 4–1; 46–1 through 46–15.

Provenience	*Sample Number*	*Hydration Layer Thickness in Microns*	*Archaeological Estimated Dates in Years* B.P.	*Obsidian Estimated Date in Years* B.P.	*Comment*
ALASKA — submitted by J. L. Giddings, Haffenreffer Museum of the American Indian, Brown University					
Denbigh Flint complex; level in situ at Iyatayet site, Cape Denbigh, Norton Bay, Alaska	7–3b	1.9	4500–8500	9000 (G)	Close to the estimated age.
	7–3c	1.7	4500–8500	6400 (G)	Within the estimated range; reference point for Scale G.
	7–3d	1.6	4500–8500	6000 (G)	Within the estimated range.
	7–3e	2.5	4500–8500	15,000 (G)	Older than estimated; unexplained at present.
Same; No. 1YPE2/DFC	20–1	2.2	4500–8500	14,000 (G)	Older than estimated; unexplained at present.
Same; No. 1YPB/DFC	20–2	1.6	4500–8500	6200 (G)	Reference point for Scale G.
Same; No. 1YPE–1/DFC	20–3	1.9	4500–8500	8800 (G)	Close to estimated range.
Same; No. 1YZ–5B/DFC	20–4	1.8	4500–8500	7400 (G)	Within the estimated range.
ALASKA — submitted by Ralph Solecki, Department of Anthropology, Columbia University					
Lake Natuakruak, Brooks Range, Alaska; Denbigh Flint complex, surface or under turf; Solecki favors 7000–8000 years	7–1b	0.98	7000–8000	2000 (G)	Disagreement unexplained at present; there is a possibility that other culture complexes are associated or rate is incorrect.
	7–1b (repeat)	1.1	7000–8000	2500 (G)	
	7–1c	1.3	7000–8000	3800 (G)	
Anaktuvuk Pass, Brooks Range; believed by Solecki to belong to Denbigh Flint complex	7–2	0.78	7000–8000	1300 (G)	Disagreement unexplained at present; there is a possibility that other culture complexes are associated or rate is incorrect.
ALASKA — submitted by Helge Larsen, Nationalmuseet, Etnografisk Samling, Denmark					
	7–4	0.54	1200	1000 (G)	Reference point for Scale G.

Anaktuvuk Pass, Brooks Range; believed by Solecki to belong to Denbigh Flint complex	7–2	0.78	7000–6000	1500 (G)	
ALASKA — submitted by Helge Larsen, Nationalmuseet, Etnografisk Samling, Denmark					
From Ipiutak house, P 7609, Deering, Alaska; about 1200 years B.P. based an radiocarbon	37–1	0.74	1200	1000 (G)	Reference point for Scale G.
ALASKA — submitted by Richard S. MacNeish, National Museum of Canada					
NiUK–1, New Mountain, 288–1A, Pit 32, NW Yukon; 6th cultural horizon	20–5	0.74	5000	1000 (G)	Younger than estimated age; possibly the wrong rate of hydration is being used but at present no better available until larger collections are available for study.
	20–5 (repeat)	0.78	5000	1100 (G)	
NiUK–1, Firth River, 20–4B, Pit 6, NW Yukon; 4th cultural horizon	20–6	0.83	4000	1500 (G)	
NiUK–1, Joe Creek, 121–4A, Pit 16, NW Yukon; 6th cultural horizon	20–7	0.64	3000	800 (G)	
JeUc–3, Champagne; horizon 1, SW Yukon but on high and cold side of mountain	20–8	0.98	7000	2000 (G)	
KKVA–2, Champagne, SW Yukon; horizon 2	20–9	2.6	7000–4000	7200 (F)	Welded tuff. Close to range of estimated dates and could be thought as a reference point for Scale F.
LaUH–2, Champagne, SW Yukon; horizon 3	20–10	2.6	7000–4000	7200 (F)	
JlVg–3, Gladstone, SW Yukon; horizon 3	20–11	1.1	7000–4000	1200 (F)	Too recent; possibly a chip from a later period; otherwise unexplained at present.
JeVc–4, Gladstone, SW Yukon; horizon 3	20–12	2.1	7000–4000	4600 (F)	Within the range of estimated dates.
KfVh–1, Taye, SW Yukon; horizon 4	20–13	1.8	4000–1700	3400 (F)	
JeVc–2, Taye, SW Yukon; horizon 4	20–14	2.6	4000–1700	7200 (F)	Older than estimates; possibly the re-use of older artifact.
JFVg–1, Taye Lake, SW Yukon; horizon 5	20–16	2.0	1700–1000	4200 (F)	
JbUG–1, Bennett, SW Yukon; horizon 6	20–17	1.1	500	1200 (F)	
CALIFORNIA — submitted by Alice P. Hunt from material collected for National Park Service					
Death Valley I, Surface site, age of early recent period of 5000–12,000 years B.P. or according to Antevs 9000 years B.P.	5–1	12.8	5000–12,000 9000	25,000 (D)	Older than estimates; exposure to intense sun due to specimen being a surface find increases the rate of hydration. Scale for this not fully worked out at present.
Death Valley, 3, Surface site, Early Christian Era; about A.D. 800–1100	5–2	9.1	1150–850	13,000 (D)	
CALIFORNIA — submitted by W. J. Wallace through Donovan Clark, Stanford University and U.S. Geological Survey, Menlo Park					
West Berkeley Mound, fragment of obsidian point. Ala–307, Unit G–4, 34 inches E, 25 inches N of SW corner, 175 inches deep; Univ. of California No. 1–123413; closest radiocarbon sample is from depth of 180–192 inches M–126: 3140±300 years B.P.	38–1	3.6	2840–3440	2000 (D)	Slightly younger than predicted.
Same; Unit H–14, 15 inches E, 24 inches N of SW corner, 181 inches deep; Univ. of California No. 1–207606; radiocarbon sample M–126: 3140±300 years B.P.	38–2	4.5	2840–3440	3100 (D)	Good agreement.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	*Sample Number*	*Hydration Layer Thickness in Microns*	*Archaeological Estimated Dates in Years B.P.*	*Obsidian Estimated Date in Years B.P.*	*Comment*
COASTAL GUATEMALA — submitted by Michael D. Coe, Department of Anthropology, University of Tennessee					
La Victoria site, near Ocós, Guatemala, Block E–3; Level 1, 0–0.30 m., K–33a; Marcos-Crucero phases, mixed refuse; Marcos phase A.D. 700–900; Crucero phase 200 B.C.–A.D. 200	45–1	5.1	1050–2150	2400 (B)	Re-use of older artifact.
Same; Level 3, 0.60–0.90 m., K–33c; Marcos-Crucero phases, mixed refuse	45–2a	3.6	1050–2150	1200 (B)	Within the estimated range.
Same; Level 3, Marcos-Crucero phases mixed	45–2b	5.0	1050–2150	2300 (B)	Re-use of older artifact.
	45–2c	7.2	1050–2150	4700 (B)	Re-use of older artifact.
	45–2d	4.6	1050–2150	1900 (B)	Within the estimated range.
	45–2e	4.7	1050–2150	2000 (B)	Within the estimated range.
Same; Level 4, 0.90–1.20 m., K–33d; Conchas phase; Subphase 2, Conchas phase estimated 850–200 B.C.	45–3b	5.1	2150–2800	2400 (B)	Re-use of older artifact.
Same; Level 4, Conchas phase	45–3c	5.9	2150–2800	3200 (B)	Re-use of older artifact.
	45–3d	5.7	2150–2800	2900 (B)	Re-use of older artifact.
	45–3e	3.9	2150–2800	1400 (B)	Probably intrusion from upper level material.
	45–3f	5.3	2150–2800	2600 (B)	Within the estimated range.
Same; Level 5, 1.20–1.50 m., K–33e; Conchas phase	45–4a	4.6	2150–2800	1900 (B)	Probably intrusion from upper level material.
Same; Level 5, Conchas phase	45–4b	4.9	2150–2800	2200 (B)	Within the estimated range.
	45–4f	5.3	2150–2800	2600 (B)	Within the estimated range.
Same; Level 6, 1.50–1.80 m., K–33f; Conchas phase	45–5a	4.5	2150–2800	1800 (B)	Probably intrusion from upper level material.
Same; Level 7, 1.80–2.10 m., K–33g; Conchas phase	45–6b	5.3	2150–2800	2600 (B)	Within the estimated range.
Same; Level 7, Conchas phase	45–6c	4.9	2150–2800	2200 (B)	Within the estimated range.
	45–6d	5.6	2150–2800	2800 (B)	Within the estimated range.
	45–6a	5.9	2150–2800	3150 (B)	Re-use of older artifact.
Same; Level 8, 2.10–2.40 m., K–33h; Conchas phase	45–7a	5.7	2150–2800	2900 (B)	Re-use of older artifact.
Same; Level 8, Conchas phase	45–7c	5.3	2150–2800	2600 (B)	Within the estimated range.
Same; Level 9, 2.40–2.70 m., K–33i; Conchas phase	45–8a	5.3	2150–2800	2600 (B)	Within the estimated range.
Same; Level 9, Conchas phase	45–8b	4.7	2150–2800	2000 (B)	Within the estimated range.
	45–8c	6.4	2150–2800	3700 (B)	Re-use of older artifact.
	45–8d	5.6	2150–2800	2800 (B)	Within the estimated range.
	45–8e	5.9	2150–2800	3200 (B)	Re-use of older artifact.
Same; Level 10, 2.70–3.00 m., K–33j; Conchas phase	45–9a	7.5	2150–2800	5100 (B)	Re-use of older artifact.
Same; Level 10, Conchas phase	45–9b	4.8	2150–2800	2100 (B)	Close to the estimated date.
	45–9c	5.9	2150–2800	3200 (B)	Re-use of older artifact.

Same; Level 10, 2.70–3.00 m., K–33j; Conchas phase	45–9a	7.3	2150–2800	5100 (B)	
Same; Level 10, Conchas phase	45–9b	4.8	2150–2800	2100 (B)	Close to the estimated date.
	45–9c	5.9	2150–2800	3200 (B)	Re-use of older artifact.
	45–9d	5.9	2150–2800	3200 (B)	Re-use of older artifact.
	45–9e	4.8	2150–2800	2100 (B)	Close to the estimated range.
Same; Level 11, 3.00–3.30 m., K–33k; Conchas phase; break where Subphase 1 begins; radiocarbon shell dates, W–836: 2150±240 B.P.	45–10a	5.4	2150–2800	2600 (B)	Within the estimated range; radiocarbon dates on the young side of estimated range.
Same; Level 11, Conchas phase	45–10b	6.0	2150–2800	3300 (B)	Re-use of older artifact.
	45–10c	5.7	2150–2800	2900 (B)	
	45–10d	6.1	2150–2800	3400 (B)	
	45–10e	5.8	2150–2800	3100 (B)	
	45–10f	6.7	2150–2800	4100 (B)	
Same; Level 12, 3.30–3.60 m., K–33l; Conchas phase; radiocarbon dates of shell, W–836: 2080±240 years B.P.	45–11a	6.6	2150–2800	4000 (B)	Re-use of older artifact. Radiocarbon dates for level are not consistent with those from Level 11; unexplained; possible mixture of refuse.
Same; Level 12, Conchas phase	45–11b	5.4	2150–2800	2600 (B)	Within the estimated range.
	45–11c	6.1	2150–2800	3400 (B)	Re-use of older artifact.
	45–11d	5.7	2150–2800	2900 (B)	
	45–11e	6.2	2150–2800	3500 (B)	
	45–11f	5.9	2150–2800	3200 (B)	
Same; Level 13, 3.60–3.90 m., K–33m; mixed level of Conchas phase and Ocós phase; Ocós phase estimated to be 850–1500 B.C. or earlier	45–12a	3.9	2150–2800 2800–3450	1400 (B)	Probably intrusion from upper level material.
Same; Level 13, Conchas-Ocós phases mixed	45–12b	4.8	2150–3450	2100 (B)	Close to estimated age of Conchas phase.
	45–12c	5.2	2150–3450	2500 (B)	Within the range of estimated age of Conchas phase.
	45–12d	5.1	2150–3450	2400 (B)	Within the range of estimated age of Conchas phase.
	45–12e	6.2	2150–3450	3500 (B)	Close to lower range of estimated age of Ocós phase.
	45–12f	5.9	2150–3450	3200 (B)	Within the range of estimated age of Ocós phase.
Same; Level 14, 3.90–4.20 m., K–33n; Ocós phase, 850–1500 B.C. or earlier	45–13b	6.0	2800–3450	3300 (B)	Within the estimated range.
Same; Level 14, Ocós phase	45–13c	5.4	2800–3450	2600 (B)	
	45–13d	5.7	2800–3450	2900 (B)	
	45–13e	6.1	2800–3450	3400 (B)	
	45–13f	6.8	2800–3450	4200 (B)	Slightly older than estimated; possibly means the Ocós phase lasts longer than predicted. Ceramic affiliations with Ecuador suggest this to be the case; see text.
Same; Level 15, 4.20–4.50 m., K–33c; Ocós phase	45–14d	5.0	2800–3450	2300 (B)	Probably intrusion from upper level material.
Same; Level 16, 4.50–4.80 m., K–33p; Ocós phase	45–15a	6.6	2800–3450	4000 (B)	Slightly older than estimated; possibly means that the Ocós phase lasts longer than predicted. Ceramic affiliations with Ecuador suggest this to be the case; see text.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
COASTAL GUATEMALA — submitted by Michael D. Coe, Department of Anthropology, University of Tennessee (continued):					
La Victoria site, near Ocós, Guatemala Block E–3; Level 16, Ocós phase	45–15c	7.0	2800–3450	4500 (B)	Slightly older than estimated; possibly means that the Ocós phase lasts longer than predicted. Ceramic affiliations with Ecuador suggest this to be the case; see text.
	45–15d	5.7	2800–3450	2900 (B)	Within the estimated range.
Same; Level 17, 4.80–5.10 m., K–33q; Ocós phase	45–16a	6.2	2800–3450	3500 (B)	Close to estimated range.
Same; Level 17, Ocós phase	45–16b	6.4	2800–3450	3700 (B)	Slightly older than estimated; possibly means that Ocós phase lasts longer than predicted. Ceramic affiliations with Ecuador suggest this to be the case; see text.
Same; Level 19, 5.40–5.70 m., K–33s; Ocós phase	45–17c	6.7	2800–3450	4100 (B)	
Same; Level 19, Ocós phase	45–17d	6.6	2800–3450	4000 (B)	
	45–17e	5.7	2800–3450	2900 (B)	Within the estimated range.
	45–17f	4.7	2800–3450	2000 (B)	Probably intrusion from upper level material.
EAST AFRICA — submitted by L. S. B. Leakey, Coryndon Museum, Nairobi, Kenya, Africa					
Mid-Acheulean stage of culture from buried land surface at Olorgesailie, Kenya	30–1a	Altered by hot springs			Due to alteration of obsidian by hot springs no normal hydration layer developed.
	30–1b	Altered by hot springs			
Hand axes from Kariendusi; probably a little later in age than 30–1; excavated from an old land surface; they had not been exposed to weathering except for a short time after being dropped by man; sealed in by large amounts of Middle Pleistocene sands, silts and grits, and accompanied by Middle Pleistocene fauna; No. KR X.5a, Kenya	30–2a	20.2		73,000 (D)	According to some estimates of Middle Pleistocene this is too young. After several hundred thousand years the hydration layer spalls off and hydration begins again; this could account for the situation, or else erosion removed part of the hydration layer.
Same; No. KR 1931–3883, x.5.a	30–2c	20.2		73,000 (D)	
Old swamp deposits at Weatherall's site at the Kinangap Kenya; culture is called "Pseudo Stillbay"; geologists and Leakey place specimens at the closing stages of Middle Pleistocene and date most of the major faulting of the Great Rift Valley in Kenya; Z 2, 1939	30–3a	Badly eroded			So badly eroded no hydration rims left, that would date reliably.
	30–3b	Badly eroded			
	30–3c	Badly eroded			
Cartwrights site in Naivasha, Kenya; "Pseudo Stillbay"	31–1a, b, c, d	Burned			Burned; surfaces altered.
True Stillbay culture belonging to second half of Upper Pleistocene from rock shelter near Kaimbu, Kenya; BIV/Y.11.d	31–2a	15.1		35,000 (D)	
Same; CIV/Y.11.d	31–2b	13.6		29,000 (D)	
Gamble's Cave, Kenya; from cave deposits resting immediately on the 510-foot beach of second maximum of the Gamblian Plu-	31–3b	2.1	20,000–25,000	650 (D)	

Kaimbu, Kenya; BIV/Y.11.d					
Same; CIV/Y.11.d	31–2b	13.6		29,000 (D)	
Gamble's Cave, Kenya; from cave deposits resting immediately on the 510-foot beach of second maximum of the Gamblian Pluvial; little later than second peak of the climatic change of Upper Pleistocene; G.C., 1952 A	31–3b	2.1	20,000–25,000	650 (D)	Old hydration layers probably eroded off.
	31–3c	4.7	20,000–25,000	3400 (D)	
	31–3d	Poor obsidian	20,000–25,000		Character of obsidian makes it difficult to see a hydration layer.
Gamble's Cave, Kenya; specimens from a slightly more recent age from No. 31–3 coming from 6 feet above the other deposit, but well within the later stages of the Upper Pleistocene; 500 to several thousand years younger than 31–3 samples; G.C. 1952, BQ 48	31–4a	2.2	19,500–23,000	750 (D)	Old hydration layers probably eroded off.
	31–4c	2.6	19,500–23,000	1100 (D)	
	31–4d	1.8	19,500–23,000	500 (D)	
Gamble's Cave, Kenya; specimens 4 feet higher than those of 31–4, belonging near the end of the Upper Pleistocene; Q–4–D	32–1a	1.4	Younger than 19,500–23,000	300 (D)	
	32–1b	3.5	19,500–23,000	1900 (D)	
	32–1c	8.3	19,500–23,000	11,000 (D)	Hydration layer thick, but date not old enough, some of layer probably eroded off.
Gamble's Cave, Kenya; from deposit in cave lying between two deposits of wind blown desertic sand; believed that this deposit corresponds with the Makalian wet phase, if so estimated dates are: GII, 11–3(Pl) (about 10,000–2000 B.C.)	32–2a	0.78	9000 av. 4000–12,000	100 (D)	Mirror-like surface and razor edge make exposure to wind-blown sand unlikely. Authors suspect recent introduction of these artifacts.
Same; GII, 121 (Pl)	32–2b	0.93	9000	100 (D)	
Weatherall's site, Kinangop, Kenya; flakes in situ in geological deposits that contain "Pseudo-Stillbay" culture; partly exposed by weathering Pre-Würm I, close of Middle Pleistocene or beginning of Upper Pleistocene	40–1b	5.0		3800 (D)	Shows recent erosion of all surfaces.
	40–1c	7.0		7600 (D)	
	40–1e	6.1		5700 (D)	
Late Stillbay site embedded in a geological deposit at the Little Gilgil River; belong to time of the decline of second maximum of Gamblian Pluvial, and believed to be slightly younger than Stillbay specimens 31–2; all specimens waste flakes from factory site and in situ	40–3c	6.6		6700 (D)	Younger than estimated; possibly erosion might have removed some of surfaces.
	40–3d	28.2		122,000 (D)	Oldest sample measured.
Waste flakes from a late Neolithic living floor underneath 10 inches of humus and associated with pottery from a site under the Little Gilgil River	41–1b	3.8	3000 or younger	2200 (D)	Close to estimated age.
From the Neolithic site of Njoro River rock shelter; this Neolithic material is infinitely younger than specimens from Gamble's Cave, Upper Kenya Capsian; estimated at 2800 years B.P. but radiocarbon places it around 3000 years B.P.; No. 461	41–2a	3.8	3000	2200 (D)	No evidence of hydration on three different thin sections; hydration layer probably eroded off.
	41–2b		3000		

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
ECUADOR — submitted by Clifford Evans and Betty J. Meggers, Division of Archeology, U.S. National Museum					
Chorrera, Site R–B–1, Babahoyo River, Los Rios Province, coastal Ecuador; excavated by Evans, Meggers, and Estrada (1957, *American Antiquity*, Vol. 22, No. 3, pp. 235–47); Level 0.0–0.15 through Level 1.20–1.35 m. is Milagro period (A.D. 500–1500); Level 1.35–1.50 through 2.85–3.00 m. is Tejar period (Desarollo Regional period, A.D. 500–500 B.C.); Level 3.00–3.15 through Level 3.75–3.90 m. is Chorrera period (500–1500 B.C.); for discussion of dating, see text. Level 0.0–0.15 m.; Milagro period.	1–2A	4.7	1450–450	2000 (B)	Re-use of older artifact.
Same; Level 0.0–0.15 m.; Milagro period	1–2B	0.97	1450–450	86 (B)	Post-European; unrelated to aboriginal occupation.
	1–2C	6.1	1450–450	3400 (B)	
	1–2D	4.6	1450–450	1900 (B)	
Same; Level 0.15–0.30 m.; Milagro period	1–3A	4.6	1450–450	1900 (B)	Re-use of older artifact.
	1–3B	4.6	1450–450	1900 (B)	
	1–3D	5.9	1450–450	3200 (B)	
Same; Level 0.30–0.45 m.; Milagro period	1–4A	3.9	1450–450	1400 (B)	Good agreement, Milagro period.
	1–4B	3.0	1450–450	820 (B)	
	1–4D	4.6	1450–450	1900 (B)	Re-use of older artifact.
Same; Level 0.45–0.60 m.; Milagro period	1–5A	1.6	1450–450	230 (B)	Post-European; unrelated to aboriginal occupation.
	1–5B	5.3	1450–450	2600 (B)	
	1–5D	4.5	1450–450	1800 (B)	
Same; Level 0.60–0.75 m.; Milagro period	1–6A	6.2	1450–450	3500 (B)	Re-use of older artifact.
	1–6B	6.2	1450–450	3500 (B)	
	1–6D	6.3	1450–450	3600 (B)	
Same; Level 0.75–0.90 m.; Milagro period	1–7A	6.2	1450–450	3500 (B)	
	1–7B	3.0	1450–450	820 (B)	Good agreement; Milagro period.
	1–7D	4.8	1450–450	2100 (B)	
Same; Level 0.90–1.05 m.; Milagro period	1–8A	6.2	1450–450	3500 (B)	Re-use of older artifact.
Same; Level 1.05–1.20 m.; Milagro period	1–9A	6.1	1450–450	3400 (B)	
	1–9B	3.1	1450–450	870 (B)	Good agreement; Milagro period.
	1–9D	5.4	1450–450	2700 (B)	Re-use of older artifact.
Same; Level 1.20–1.35 m.; Milagro period	1–10A	5.5	1450–450	2800 (B)	
	1–10B	3.0	1450–450	820 (B)	Reference point, Scale B.
	1–10D	6.4	1450–450	3700 (B)	Re-use of older artifact.
Same; Level 1.35–1.50 m.; Tejar period	1–11A	5.7	2450–1450	3000 (B)	Re-use of older artifact.
	1–11B	3.0	2450–1450	820 (B)	Mechanical mixture of Milagro period speci-

Same; Level 1.20–1.35 m.; Milagro period	1–10B	3.0	1450–450	820 (B)	Reference point, Scale B.
	1–10D	6.4	1450–450	3700 (B)	Re-use of older artifact.
Same; Level 1.35–1.50 m.; Tejar period	1–11A	5.7	2450–1450	3000 (B)	Re-use of older artifact.
	1–11B	3.0	2450–1450	820 (B)	Mechanical mixture of Milagro period specimen in earlier strata.
Same; Level 1.50–1.65 m.; Tejar period	1–12A	5.6	2450–1450	2900 (B)	Re-use of older artifact.
	1–12B	3.0	2450–1450	820 (B)	Mechanical mixture of Milagro period specimen in earlier strata.
Same; Level 1.65–1.80 m.; Tejar period	1–13A	6.2	2450–1450	3500 (B)	Re-use of older artifact.
	1–13B	2.9	2450–1450	760 (B)	Mechanical mixture of Milagro period specimen in earlier strata.
Same; Level 1.80–1.95 m.; Tejar period	1–14A	4.4	2450–1450	1800 (B)	Good agreement; Tejar period.
	1–14B	3.0	2450–1450	820 (B)	Mechanical mixture of Milagro period specimen in earlier strata.
	1–14C	5.5	2450–1450	2800 (B)	
Same; Level 1.95–2.10 m.; Tejar period	1–15A	6.4	2450–1450	3700 (B)	Re-use of older artifact.
	1–15A (repeat)	6.2	2450–1450	3500 (B)	
	1–15B	5.3	2450–1450	2600 (B)	
Same; Level 2.10–2.25 m.; Tejar period	1–16A	4.6	2450–1450	1900 (B)	Good agreement; Tejar period.
	1–16A (repeat)	4.6	2450–1450	1900 (B)	
	1–16B	4.1	2450–1450	1500 (B)	
Same; Level 2.25–2.40 m.; Tejar period	1–17A	5.4	2450–1450	2700 (B)	Re-use of older artifact.
	1–17B	3.2	2450–1450	930 (B)	Probably mechanical mixture from Milagro period.
	1–17B (repeat)	3.3	2450–1450	990 (B)	
	1–17C	4.9	2450–1450	2200 (B)	Good agreement; Tejar period.
Same; Level 2.40–2.55 m.; Tejar period	1–18A	5.2	2450–1450	2500 (B)	Good agreement; Tejar period, transition to Chorrera period.
	1–18B	4.7	2450–1450	2000 (B)	Good agreement; Tejar period.
Same; Level 2.55–2.70 m.; Tejar period	1–19A	5.2	2450–1450	2500 (B)	Good agreement; Tejar period, transition to Chorrera period.
	1–19B	3.4	2450–1450	1100 (B)	Unexplained unless due to mechanical mixture; too young.
Same; Level 2.70–2.85 m.; Tejar period	1–20A	4.4	2450–1450	1800 (B)	Good agreement; Tejar period.
	1–20A (repeat)	4.6	2450–1450	1900 (B)	
	1–20B	6.1	2450–1450	3400 (B)	Re-use of older artifact.
Same; Level 2.85–3.00 m.; Tejar period	1–21	6.7	2450–1450	4100 (B)	
Same; Level 3.00–3.15 m.; Chorrera period	1–22A	5.2	3450–2450	2500 (B)	Good agreement; Tejar period transition to Chorrera period.
	1–22D	5.8	3450–2450	3100 (B)	Good agreement; Chorrera period.
Same; Level 3.15–3.30 m.; Chorrera period	1–23	5.3	3450–2450	2600 (B)	
Same; Level 3.30–3.45 m.; Chorrera period	1–24A	6.1	3450–2450	3400 (B)	Chorrera period; reference point for Scale B.
	1–24B	7.6	3450–2450	5300 (B)	Too old; may be an original surface that was unchipped.
Same; Level 3.45–3.60 m.; Chorrera period	1–25	6.5	3450–2450	3900 (B)	Slightly older than estimated dates for Chorrera period.
	1–25 (repeat)	6.4	3450–2450	3700 (B)	

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	*Sample Number*	*Hydration Layer Thickness in Microns*	*Archaeological Estimated Dates in Years B.P.*	*Obsidian Estimated Date in Years B.P.*	*Comment*
ECUADOR — submitted by Clifford Evans and Betty J. Meggers, Division of Archeology, U.S. National Museum (continued):					
Chorrera, Site R–B–1, Babahoyo River, Los Rios Province, coastal Ecuador; excavated by Evans, Meggers, and Estrada (1957, *American Antiquity*, Vol. 22, No. 3, pp. 235–47); Level 0.0–0.15 through Level 1.20–1.35 m. is Milagro period (A.D. 500–1500); Level 1.35–1.50 through 2.85–3.00 m. is Tejar period (Desarollo Regional period, A.D. 500–500 B.C.); Level 3.00–3.15 through Level 3.75–3.90 m. is Chorrera period (500–1500 B.C.); for discussion of dating, see text. Level 3.60–3.75 m.; Chorrera period	1–26	6.1	3450–2450	3400 (B)	Chorrera period; reference point, Scale B.
Same; Level 3.75–3.90 m.; Chorrera period	1–27	5.9	3450–2450	3200 (B)	Chorrera period; reference point, Scale B, for beginning of Chorrera period at 3500 years B.P.
Site G–D–8 Naupe, Daule River, Guayas Province; Milagro period occupation at site on top of Chorrera and Tejar period materials so that upper levels of strata cuts are of the late culture, just as at the Chorrera site; same dating as for that site, see explanation opposite item 1–2A on Table. Cut 3, Level 0.20–0.40 m.; Milagro period	27–1b	5.4	1450–450	2700 (B)	Re-use of older artifact.
Same; Cut 3, Level 0.20–0.40 m.; Milagro period	27–1c	5.7	1450–450	3000 (B)	
	27–1d	5.1	1450–450	2400 (B)	
	27–2a	5.4	1450–450	2700 (B)	
	27–2b	5.5	1450–450	2800 (B)	
Same; Cut 3, Level 0.60–0.80 m.; Tejar period	27–3a	5.4	2450–1450	2700 (B)	Re-use of older artifact, but not too far from estimated age.
	27–3b	5.0	2450–1450	2300 (B)	Good agreement; Tejar period.
	27–3c	6.7	2450–1450	4100 (B)	Older than estimated age for Tejar or Chorrera periods; unexplained.
Same; Cut 3, Level 0.80–1.00 m.; Chorrera period	27–4	5.9	3450–2450	3200 (B)	Good agreement; Chorrera period.
Same; Cut 3, Level 1.20–1.40 m.; Chorrera period	27–5	6.3	3450–2450	3600 (B)	Slightly older than estimated age, but not too far from Chorrera period.
Same; Cut 4, Level 0.0–0.20 m.; Milagro period	27–6a	5.1	1450–450	2400 (B)	
	27–6b	4.7	1450–450	2000 (B)	
	27–6d	5.7	1450–450	3000 (B)	Re-use of older artifact.
	27–6e	4.6	1450–450	1900 (B)	
	27–6f	6.6	1450–450	4000 (B)	Older than estimated ages for even Chorrera period; unexplained.
Same; Cut 4, Level 0.0–0.20 m.; Milagro period	27–6g	5.2	1450–450	2500 (B)	Re-use of older artifact.
Same; Cut 4, 0.20–0.40 m.; Milagro period and	27–7a	2.8	1450–450	700 (B)	Agreement with Milagro period.

	27–6f	6.6	1450–450	4000 (B)	Older than estimated ages for even Chorrera period; unexplained.
Same; Cut 4, Level 0.0–0.20 m.; Milagro period	27–6g	5.2	1450–450	2500 (B)	Re-use of older artifact.
Same; Cut 4, 0.20–0.40 m.; Milagro period and Tejar period materials intermixed	27–7a	2.8	1450–450 2450–1450	700 (B)	Agreement with Milagro period.
Same; Cut 4, 0.20–0.40 m.; Tejar period	27–7b	5.5	2450–1450	2800 (B)	Re-use of older artifact.
	27–7c	7.0	2450–1450	4500 (B)	Older than estimated ages for any period at site; unexplained.
	27–7d	4.7	2450–1450	2000 (B)	Good agreement; Tejar period.
	27–7e	5.1	2450–1450	2400 (B)	
Same; Cut 4, 0.20–0.40 m,; Milagro period mixture; note 27–7a	27–7f	3.5	1450–450	1100 (B)	Good agreement; Milagro period.
Same; Cut 4, 0.20–0.40 m.; Tejar period	27–7g	5.5	2450–1450	2800 (B)	Re-use of older artifact.
	27–7h	4.6	2450–1450	1900 (B)	Good agreement; Tejar period.
	27–7i	5.2	2450–1450	2500 (B)	
	27–7j	5.2	2450–1450	2500 (B)	
Same; Cut 4, Level 0.40–0.60 m.; Tejar period	27–8a	4.5	2450–1450	1800 (B)	
	27–8b	6.3	2450–1450	3600 (B)	Re-use of older artifact.
	27–8c	5.1	2450–1450	2400 (B)	Good agreement; Tejar period.
	27–8d	5.0	2450–1450	2300 (B)	
	27–8e	6.1	2450–1450	3400 (B)	Re-use of older artifact.
	27–8f	5.2	2450–1450	2500 (B)	Good agreement; Tejar period.
	27–8h	5.6	2450–1450	2900 (B)	Re-use of older artifact.
Same; Cut 4, Level 0.60–0.80 m.; Chorrera period	27–9a	5.2	3450–2450	2500 (B)	Border of Tejar and Chorrera periods; agreement satisfactory.
	27–9b	5.2	3450–2450	2500 (B)	
	27–9c	5.4	3450–2450	2700 (B)	Good agreement; Chorrera period.
	27–9d	5.3	3450–2450	2600 (B)	
	27–9e	4.7	3450–2450	2000 (B)	Younger than estimate; fits the Tejar period; probably mixture.
	27–9f	5.1	3450–2450	2400 (B)	Good agreement; Chorrera period.
	27–9g	5.2	3450–2450	2500 (B)	Good agreement; Chorrera period and Tejar period border line.
	27–9h	5.6	3450–2450	2900 (B)	Good agreement; Chorrera period.
	27–9i	5.5	3450–2450	2800 (B)	
	27–9j	5.5	3450–2450	2800 (B)	
Same; Cut 4, Level 0.80–0.90 m.; Chorrera period	27–10a	5.6	3450–2450	2900 (B)	
	27–10c	6.2	3450–2450	3500 (B)	Close to estimate; within the possible range of Chorrera period.
	27–10d	6.2	3450–2450	3500 (B)	
	27–10e	5.5	3450–2450	2800 (B)	Good agreement; Chorrera period.
	27–10g	6.3	3450–2450	3600 (B)	Slightly older than estimated age of Chorrera period.
	27–10h	5.2	3450–2450	2500 (B)	Good agreement; Chorrera period and Tejar period border line.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
ECUADOR — submitted by Clifford Evans and Betty J. Meggers, Division of Archeology, U.S. National Museum (continued):					
Site G–D–11; Bijagual, Daule River, Guayas Province; Desarollo Regional period (A.D. 500–500 B.C.); Cut 1, Level 0.0–0.20 m.; Desarollo Regional period	27–11	4.2	2450–1450	1600 (B)	Good agreement with Desarollo Regional period.
Same; Cut 1, Level 0.60–0.80 m.; Desarollo Regional period	27–12	5.0	2450–1450	2300 (B)	Good agreement with Desarollo Regional period.
	27–13a	5.2	2450–1450	2500 (B)	Within the estimated range of Desarollo Regional period.
Same; Cut 1, Level 0.80–1.00 m.; Desarollo Regional period	27–13b	3.2	2450–1450	930 (B)	Too recent; unexplained at present.
Same; Cut 1, Level 1.00–1.30 m.; Desarollo Regional period	27–14a	5.2	2450–1450	2500 (B)	Within the estimated range of Desarollo Regional period.
	27–14b	5.1	2450–1450	2400 (B)	Within the estimated range of Desarollo Regional period.
	27–15a	5.0	2450–1450	2300 (B)	Within the estimated range of Desarollo Regional period.
Same; Cut 1, Level 1.30–1.70 m.; Desarollo Regional period	27–15b	5.3	2450–1450	2600 (B)	Slightly older but close enough to Desarollo Regional period.
	27–15c	5.9	2450–1450	3200 (B)	Probably re-use of older material, such as Chorrera period.
Site G–M–26, Caimito Mound 2, Milagro Area, Guayas Province, Ecuador; chimney burial of the Milagro period (A.D. 500–1500)	27–16a	5.5	1450–450	2800 (B)	
Same; Milagro period	27–16b	4.6	1450–450	1900 (B)	Re-use of older material.
	27–16c	5.3	1450–450	2500 (B)	
	27–16d	4.8	1450–450	2100 (B)	
	27–16g	5.6	1450–450	2900 (B)	
Site M–28, Machalilla, Manabí Province, Ecuador. Unnumbered cut dug by Felix, Level 1.00–1.20 m. (Evans and Meggers estimate this on basis of trade sherds in Chorrera period sites to belong to Chorrera period, about 500–1500 B.C.; Estrada estimates it to be Pre-Chorrera, before 1500 B.C., see Estrada 1958, cuadro 2)	27–17	6.1	3450–2450	3400 (B)	Seems to fit the Chorrera period time range.
Site G–34, Loma Prudente, near Barcelona village in Valdivia Valley, Guayas Province, Ecuador; culturally the pottery is transitional between the Chorrera period and fully developed Guangala period (about 500 B.C.–A.D. 250)	28–1a	0.69	2450–1700	43 (B)	Modern; post-European unrelated to aboriginal occupation.
Same; Cut C, Level 0.00–0.20 m.; Early Desarollo Regional period	28–1b	2.5	2450–1700	570 (B)	Recent; see explanation in text.
Same; Cut C, Level 0.20–0.40 m.; Early Desarollo Regional period	28–2	4.4	2450–1700	1800 (B)	Within the estimated range of early Desarollo Regional period.
Same; Cut C, Level 0.40–0.60 m.; Early Desarollo Regional period	28–3a	4.4	2450–1700	1800 (B)	Within the estimated range of early Desarollo Regional period.
	28–3b	4.4	2450–1700	1800 (B)	Within the estimated range of early Desarollo Regional period.

Same; Cut C, Level 0.20–0.40 m.; Early Desarollo Regional period	28–2	4.4	2450–1700	1800 (B)	Within the estimated range of early Desarollo Regional period.
Same; Cut C, Level 0.40–0.60 m.; Early Desarollo Regional period	28–3a	4.4	2450–1700	1800 (B)	Within the estimated range of early Desarollo Regional period.
	28–3b	4.4	2450–1700	1800 (B)	
Same; Cut C, Level 0.80–1.00 m.; Early Desarollo Regional period	28–4	5.0	2450–1700	2300 (B)	
Site G–39, Loma Alta in the Valdivia Valley Drainage, Guayas Province, Ecuador; site is the late or latter half of the Desarollo Regional period (about A.D. 1–500). Cut D, Level 0.40–0.60 m.; Desarollo Regional period	28–5a	4.2	1950–1450	1600 (B)	Good agreement for Desarollo Regional period.
Same; Cut D, Level 0.40–0.60 m.; Desarollo Regional period	28–5b	4.6	1950–1450	1900 (B)	Within the range of Desarollo Regional period for site.
Site G–76, Libertad, Santa Elena Peninsula, Guayas Province, Ecuador; pottery classifies as the Chorrera period (500–1500 B.C.) Cut A, Level 0.40–0.60 m.; Chorrera period	28–8a	6.4	3450–2450	3700 (B)	Slightly older than predicted; probably the Chorrera period here on coast has a slightly older time range than inland on the rivers.
Same; Cut A, Level 0.40–0.60 m.; Chorrera period	28–8b	5.9	3450–2450	3200 (B)	Within the range; Chorrera period.
Same; Cut C, Level 0.00–0.20 m.; Chorrera period	28–9	6.2	3450–2450	3500 (B)	Close to estimated range of Chorrera period.
Same; Cut C, Level 0.60–0.80 m.; Chorrera period	28–10a	6.3	3450–2450	3600 (B)	Slightly older than predicted; possibly the Chorrera period here on coast has slightly older time range than inland on the rivers.
	28–10b	6.2	3450–2450	3500 (B)	Close to estimated range of Chorrera period.
Site G–D–1, Loma de los Naranjos, Palestina, Daule River, Guayas Province; Milagro period with a few items of trade from Manteño period dating A.D. 500–1500. Cut 1, Level 0.15–0.30 m.; Milagro period	28–12	5.3	1450–450	2600 (B)	
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	28–13	5.4	1450–450	2700 (B)	
Same; Cut 1, Level 0.90–1.05 m.; Milagro period (area near Manteño period trade vessel)	28–14	5.8	1450–450	2800 (B)	Re-use of older artifact.
Same; Cut 1, Level 1.05–1.20 m.; Milagro period	28–15a	5.3	1450–450	2600 (B)	
	28–15b	5.1	1450–450	2400 (B)	
Same; Cut 1, Level 1.20–1.35 m.; Milagro period	28–16	5.6	1450–450	2900 (B)	
Same; Cut 1, Level 1.20–1.35 m.; Milagro period (from inside lower burial jar)	28–17	4.3	1450–450	1700 (B)	
Site G–D–2, Loma de las Lechuzas, Daule River, Guayas Province; Milagro period (A.D. 500–1500). Cut 1, Level 0.00–0.15 m.; Milagro period	28–18a	4.0	1450–450	1500 (B)	Close to range of Milagro period.
	28–18a (repeat)	4.1	1450–450	1500 (B)	
Same; Cut 1, Level 0.00–0.15 m.; Milagro period	28–18b	2.3	1450–450	480 (B)	Within range of Milagro period.
	28–18c (two rims)	4.7	1450–450	2000 (B)	Re-use of older artifact.
	28–18c (two rims)	2.2	1450–450	440 (B)	Suggests that this older artifact was chipped in one area by Milagro period peoples; hence the two different thicknesses.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
ECUADOR — submitted by Clifford Evans and Betty J. Meggers, Division of Archeology, U.S. National Museum (continued):					
Site G–D–2, Loma de las Lechuzas, Daule River, Guayas Province; Milagro period (A.D. 500–1500). Cut 1, Level 0.00–0.15 m.; Milagro period	28–18d	4.6	1450–450	1900 (B)	
	28–18e	4.4	1450–450	1800 (B)	
	28–18g	4.5	1450–450	1800 (B)	Re-use of older artifact.
Same; Cut 1, Level 0.15–0.30 m.; Milagro period	28–19c	4.3	1450–450	1700 (B)	
	28–19e	4.3	1450–450	1700 (B)	
	28–19g	4.3	1450–450	1700 (B)	
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	28–20a	3.7	1450–450	1200 (B)	Within the range of Milagro period.
	28–20b	5.3	1450–450	2600 (B)	Re-use of older material.
	28–20c	4.1	1450–450	1500 (B)	Close to estimated range of Milagro period or could be re-use of older material.
	28–20d	4.6	1450–450	1900 (B)	
	28–20e	4.4	1450–450	1800 (B)	
	28–20g	4.5	1450–450	1800 (B)	
Same, Cut 1, Level 0.45–0.60 m.; Milagro period	29–1b	4.6	1450–450	1900 (B)	
	29–1c	5.7	1450–450	3000 (B)	
	29–1d	4.6	1450–450	1900 (B)	Re-use of older material.
	29–1e	4.2	1450–450	1600 (B)	
Site G–M–10; Altamirano, Milagro Area, Guayas Province, Ecuador; Milagro period (A.D. 500–1500)	29–2a	4.5	1450–450	1800 (B)	
Same; Cut 1, Level 0.00–0.15 m.; Milagro period	29–2b	4.6	1450–450	1900 (B)	
	29–2c	4.5	1450–450	1800 (B)	
	29–2d	4.1	1450–450	1500 (B)	Close to estimated range of Milagro period or could be re-use.
	29–2e	4.6	1450–450	1900 (B)	Re-use of older material.
	29–2f	4.7	1450–450	2000 (B)	
	29–2g	3.9	1450–450	1400 (B)	Within the range of Milagro period.
Same; Cut 1, Level 0.15–0.30 m.; Milagro period	29–3a	4.6	1450–450	1900 (B)	Re-use of older artifact.
	29–3b	4.6	1450–450	1900 (B)	
	29–3c	3.2	1450–450	930 (B)	Within the range of Milagro period.
	29–3d	4.7	1450–450	2000 (B)	Re-use of older artifact.
	29–3f	4.2	1450–450	1600 (B)	
	29–3g	4.0	1450–450	1500 (B)	Within the range of Milagro period.
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	29–4a	4.2	1450–450	1600 (B)	Re-use of older artifact.
	29–4c	5.1	1450–450	2400 (B)	
	29–4d	4.8	1450–450	2100 (B)	
	29–4e	4.6	1450–450	1900 (B)	
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	29–4f	1.6	1450–450	230 (B)	Post-European, unrelated to aboriginal occupation.
	29–4g	4.5	1450–450	1800 (B)	

	29–4d	4.8	1450–450	2100 (B)	
	29–4e	4.6	1450–450	1900 (B)	
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	29–4f	1.6	1450–450	230 (B)	Post-European, unrelated to aboriginal occupation.
	29–4g	4.5	1450–450	1800 (B)	
Same; Cut 1, Level 0.45–0.60 m.; Milagro period	29–5a	4.7	1450–450	2000 (B)	Re-use of older artifact.
	29–5b	4.6	1450–450	1900 (B)	
	29–5c	4.2	1450–450	1600 (B)	
	29–5d	3.8	1450–450	1300 (B)	Within the range of Milagro period.
	29–5e	4.3	1450–450	1700 (B)	
Same; Cut 1, Level 0.60–0.75 m.; Milagro period	29–6a	4.8	1450–450	2100 (B)	Re-use of older artifact.
	29–6b	4.2	1450–450	1600 (B)	
	29–6c	3.5	1450–450	1100 (B)	
	29–6d	4.0	1450–450	1500 (B)	Within range of Milagro period.
	29–6e	2.7	1450–450	660 (B)	
Same; Cut 1, Level 0.75–0.90 m.; Milagro period	29–7a	4.2	1450–450	1600 (B)	Re-use of older artifact.
	29–7b	3.6	1450–450	1200 (B)	Within range of Milagro period.
	29–7c	4.1	1450–450	1500 (B)	Close enough to estimated range of Milagro period.
	29–7f	4.1	1450–450	1500 (B)	Close to estimated range of Milagro period.
Same; Cut 1, Level 0.90–1.05 m.; Milagro period	29–8a	4.1	1450–450	1500 (B)	
	29–8b	2.3	1450–450	480 (B)	
Site G–M–11; Cambio de la Balsa, Milagro Area, Guayas Province, Ecuador; Milagro period estimated A.D. 500–1500. Cut 1, Level 0.00–0.15 m.; Milagro period	29–9a	3.5	1450–450	1100 (B)	
	29–9b	3.4	1450–450	1100 (B)	
Same; Cut 1, Level 0.00–0.15 m.; Milagro period	29–9c	3.4	1450–450	1100 (B)	
	239–9d	3.3	1450–450	990 (B)	Within range of Milagro period.
	29–10a	3.3	1450–450	990 (B)	
	29–10b	2.9	1450–450	770 (B)	
Same; Cut 1, Level 0.15–0.30 m.; Milagro period	29–10c	2.6	1450–450	600 (B)	
	29–10e	3.6	1450–450	1200 (B)	
	29–10f	3.6	1450–450	1200 (B)	
	29–10g	3.6	1450–450	1200 (B)	
	29–11a	4.7	1450–450	2000 (B)	Re-use of older artifact.
	29–11c	3.5	1450–450	1100 (B)	
Same; Cut 1, Level 0.30–0.45 m.; Milagro period	29–11d	3.5	1450–450	1100 (B)	
	29–11e	2.5	1450–450	570 (B)	Within range of Milagro period.
	29–11g	3.6	1450–450	1200 (B)	
Same; Cut 1, Level 0.45–0.60 m.; Milagro period	29–12a	4.8	1450–450	2100 (B)	Re-use of older artifact.
	29–12b	3.3	1450–450	990 (B)	
Same; Cut 1, Contents of urn, below 0.90 m.; Milagro period	29–13b	3.0	1450–450	820 (B)	Within range of Milagro period.
	29–13c	3.1	1450–450	870 (B)	
	29–13d	7.0	1450–450	4500 (B)	Too old for any of periods that used obsidian; possibly the surfaces not chipped by man.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
ECUADOR — submitted by Clifford Evans and Betty J. Meggers, Division of Archeology, U.S. National Museum (continued):					
Site G–M–11; Cambio de la Balsa, Milagro Area, Guayas Province, Ecuador; Milagro period estimated A.D. 500–1500. Cut 1, contents of urn, below 0.90 m.; Milagro period	29–13e	3.1	1450–450	870 (B)	Within range of Milagro period.
Site G–31, Valdivia, Guayas Province. This site has a very early culture dated by radiocarbon from Sample W–631 of 4450 ± 200 years B.P. near the bottom of the deposit, and W–630 of 4050 ± 200 years B.P. from the middle of the cultural deposit; and on top of this deposit a later occupation by the Guangala period. The zone of transition and mixture in the refuse on part of the site is around 60 cm. deep, where sherds of both periods are found as a result of scuffling of the refuse and mechanical mixture. If obsidian is from the Valdivia culture the date will be early from around 4500 to 3600 years B.P.; if it is from the Late Guangala period it relates to about A.D. 1–500 Cut A, Level 0.40–0.60 m.	29–14	5.3	4500–3600 or 1950–1450	2600 (B)	Re-use of older artifact.
Same; Cut A, Level 0.60–0.80 m.	29–15	4.8		2100 (B)	Guangala period or later reoccupation and not of the early Valdivia culture.
Site R–Q–3, Mina de Oro, Quevedo Area, Los Rios Province, Ecuador, Milagro period of A.D. 500–1500 Cut 1, Level 0.40–0.60 m.; Milagro period	39–1	4.9	1450–450	2200 (B)	Re-use of older artifact.
Site R–Q–8, Santa Rosa site, Quevedo Area, Los Rios Province, Ecuador; Milagro period of A.D. 500–1500. Surface and minor tests over shallow refuse of site	39–2a	3.3	1450–450	990 (B)	Within the range of Milagro period.
Same; Milagro period	39–2b	4.3	1450–450	1700 (B)	Re-use of older artifact.
EGYPT — submitted by Division of Archeology, U.S. National Museum, Smithsonian Institution					
Obsidian eye of Egyptian Sacred Bull, Dahshur, Egypt; Late Ptolemaic to Early Roman with historical dates of 200 B.C. to A.D. 200; radiocarbon date of wrappings of this same bull; W–780: 2050 ± 200 years B.P.; sections 15–1a, 1b from back and side edge of artifact which is ground	15–1c	4.6	1750–2150 1850–2250	1500 (A)	Brown obsidian (trachytic?); composition affects rate of hydration; layer difficult to discern.
Same; section from front, polished surface	15–1d	5.1	1850–2250	1900 (A)	Brown obsidian (trachytic?); composition affects rate of hydration, hydration difficult to discern. Reference point for scale A.
EGYPT — submitted by Eric Young, Metropolitan Museum of Art, New York					
Pupil from inlaid eye of Coffin Light, North	15–2	8.1	3900–3850	4700 (A)	Brown crystalline obsidian (trachytic?); com-

			1900 (A)		Brown obsidian (trachytic?); composition affects rate of hydration, hydration difficult to discern. Reference point for scale A.

EGYPT — submitted by Eric Young, Metropolitan Museum of Art, New York

Pupil from inlaid eye of Coffin Lisht, North Pyramid, Reign of Amerembat I, Dynasty XII about 1950–1900 B.C.	15–2	8.1	3900–3850	4700 (A)	Brown, crystalline obsidian (trachytic?); composition affects rate of hydration. Scale A used; poor agreement.
Obsidian flake from tomb of Sample 15–2, Lisht	15–3a	7.4	3900–3850	3900 (A)	Brown obsidian (trachytic?); composition affects rate. Reference point for scale A.
	15–3b	5.3	3900–3850	3500 (C)	Normal, rhyolitic obsidian; slightly younger than anticipated but not too far off. Reference point for scale C.
Pupil from coffin eye, Cat. No. 4919, Lisht; Same	15–5	6.4	3900–3850	2900 (A)	Brown obsidian (trachytic?); composition affects rate, scale A used; agreement poor, not old enough.
Pupil from coffin eye, Cat. No. 4920, Lisht; Same	15–6	5.9	3900–3850	4300 (C)	Normal, rhyolitic obsidian; slightly older than predicted; agreement fair in light of estimated dates of periods. Reference point for scale C.

EGYPT — submitted by William S. Smith, Museum of Fine Arts, Boston

Obsidian flakes from burial pit at Der el Bersheh, Middle Egypt; pits belong to the original layout of a long rock-cut tomb. Tomb of Vizier Aha-Nekht belongs to end of First Intermediate Period (Dynasty IX–XI). Gives a reasonable date of about 2050 B.C. Museum Catalogue No. 21.76	44–1	None visible	4000		Brown obsidian (trachytic?); no hydration layer visible. Composition affects rate of hydration.
	44–2	5.5	4000	3700 (C)	Normal obsidian; good agreement.
	44–3	5.8	4000	4200 (C)	
	44–4	None visible	4000		Brown obsidian (trachytic?); no hydration layer visible. Composition affects rate of hydration.
	44–5	None visible	4000		
	44–6	None visible	4000		
	44–7	None visible	4000		
	44–8	None visible	4000		
	44–9	None visible	4000		
	44–10	None visible	4000		
	44–11	None visible	4000		

JAPAN — submitted by Professor Sosuke Sugihara, Meiji University, Tokyo, through Junius B. Bird

Gyusanbodai, Kanagawa Pref. Early Jomon age. Compare with Kamo, 3145±400 B.C. Michigan radiocarbon date	48–1a	5.2	4704–5504	4200 (D)	Within the range of age of culture.
	48–1b	3.5	4704–5504	1900 (D)	Too young; discrepancy unexplained at present.
	48–1c	6.6	4704–5504	6700 (D)	Older than range; discrepancy unexplained at present.
Oishiyama, Tokyo, Middle Jomon age. Compare with Ubayama, 2563±300 B.C.	48–2a	2.9	4222–4820	1300 (D)	Young sample suggests that it might be from a later occupation and the radiocarbon date is not necessarily associated with the obsidian samples.
	48–2b	2.7	4222–4820	1100 (D)	Same; but two samples are fairly close to each other in rim thickness so they are consistent.
Kekeiyama, Tokyo, Middle Yayoi period. About 100 B.C.–A.D. 100 by Chinese comparative data	48–4a	3.6	2059–1859	2000 (D)	Good agreement.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
JAPAN — submitted by Professor Sosuke Sugihara, Meiji University, Tokyo, through Junius B. Bird (continued):					
Kekeiyama, Tokyo, Middle Yayoi period. About 100 B.C.–A.D. 100 by Chinese comparative data	48–4b	2.0	2059–1859	620 (D)	Disagreement unexplained at present.
	48–4c	3.2	2059–1859	1600 (D)	Slightly younger; but fairly close.
Yadegawa, Nagano Pref. Microlithic Industry of unknown preceramic horizon	48–5a	4.9		3700 (D)	The series of 48–5 dates are all generally all right for the Microlithic industry if the dates are comparable to other parts of the world.
	48–5b	5.5		4700 (D)	Same. Slightly thicker rim than others.
	48–5c	4.6		3300 (D)	
Uenodaira, Nagano Pref. (Iwajuku III-Ueno-Daira) Points Industry — preceramic	48–6a	8.4		11,000 (D)	All right if time sequence like that of Europe and Near East. Equal to Würm IV period.
	48–6b	7.7		9100 (D)	
Moro, Tokyo (compare Iwajuku II, but relationship is unclear) Backed Blade Industry — preceramic	48–7a	11.0		18,700 (D)	All right if time sequence like that of Europe and Near East. Equal to Würm III period.
	48–7b	10.5		17,000 (D)	
MAYA AREA (YUCATÁN) — submitted by H. E. D. Pollock, Carnegie Institution of Washington					
Mayapán, Yucatán	3–1a	2.4	750–450	500 (B)	Good agreement.
	3–1b	2.4	750–450	500 (B)	
MAYA AREA (GUATEMALA) — submitted by William R. Coe, University Museum, Philadelphia					
No. L–27–3a, Cache K–5–2, Piedras Negras, Guatemala Maya date 9.6.0.0.0(?) converted in	18–1	2.9			Disagreement unexplained at present.
"11.16" correlation A.D. 554			1405	750 (B)	
"12.9" correlation A.D. 294			1665		
Same;	18–1 (repeat)	2.6			
"11.16" correlation A.D. 554			1405	600 (B)	
"12.9" correlation A.D. 294			1665		
No. L–142–338, Cache K–5–8, Piedras Negras, Guatemala 9.6.0.0.0(?)	18–2	0.98			
"11.16" correlation A.D. 554			1405	100 (B)	
"12.9" correlation A.D. 294			1665		
No. L–142–337, Cache K–5–8, Piedras Negras, Guatemala 9.6.0.0.0(?)	18–3	2.0			
"11.16" correlation A.D. 554			1405	400 (B)	
"12.9" correlation A.D. 294			1665		
No. L–16–919d, Cache K–5–1, Piedras Negras, Guatemala 9.6.0.0.0(?)	18–4	0.83			
"11.16" correlation A.D. 554			1405	60 (B)	
"12.9" correlation A.D. 294			1665		
No. L–16–919e, Cache K–5–1, Piedras Negras, Guatemala 9.6.0.0.0(?)	18–5	2.7			

"11.16" correlation A.D. 554			1405	60 (B)	
"12.9" correlation A.D. 294			1665		
No. L–16–919e, Cache K–5–1, Piedras Negras, Guatemala 9.6.0.0.0(?)	18–5	2.7			
"11.16" correlation A.D. 554			1405	650 (B)	Two thicknesses on same specimen suggest re-chipping of same object at later date; however disagreements unexplained at present.
"12.9" correlation A.D. 294			1665		
No. L–16–919e, Cache K–5–1, Piedras Negras, Guatamala 9.6.0.0.0(?)	18–5 (repeat)	0.94			
"11.16" correlation A.D. 554			1405	100 (B)	
"12.9" correlation A.D. 294			1665		
No. L–142–318, Cache K–5–5, Piedras Negras, Guatemala 9.12.5.0.0	18–6	1.0			
"11.16" correlation A.D. 677			1282	100 (B)	Disagreement unexplained at present; but both objects 18–6 and 18–7 from this Stela Cache give same thickness suggesting chipping at same time.
"12.9" correlation A.D. 417			1542		
No. L–142–319, Cache K–5–5, Piedras Negras, Guatemala 9.12.5.0.0	18–7	1.0			
"11.16" correlation A.D. 677			1282	100 (B)	
"12.9" correlation A.D. 417			1542		
MAYA AREA — submitted by Gordon R. Willey, Peabody Museum, Harvard University					
Copán, Honduras, C/208, flake, Chamber 2, Tomb 1 Late Classic, about A.D. 300–900	34–1	2.00	1650–1050	350 (B)	
Copán, C/232, flake, Skeleton 9, Tomb 3 Late Classic, about A.D. 300–900	34–2	2.1	1650–1050	400 (B)	
Copán, C/288, flake, Tomb 10, Postclassic, after A.D. 900	34–3b	1.6	1050	250 (B)	Disagreement unexplained at present.
Copán, C/681, knife, Under Stela 3, Maya Date 9.11.0.0.0	34–4	1.2			
"11.16" correlation A.D. 652			1307	150 (B)	
"12.9" correlation A.D. 393			1566		
Copán, 46–48–20/15238, scrap, Trench 1, Cut 7, Meter 1, Formative period, pre A.D. 300	34–5	3.8	1650	1300 (B)	Agreement better than other samples.
Copán, 46–48–20/15295, scrap, Trench 1, Cut 7, Meter 3, Formative period, pre A.D. 300	34–6	2.5	1650	550 (B)	Disagreement unexplained at present.
Copán, 46–48–20/15357, scrap, Trench 1, Cut 7, Meter 5, last part of Early Classic about A.D. 300–600	34–7	3.7	1650–1350	1200 (B)	Agreement fairly close.
Copán, 46–48–20/15533, scrap, Trench 1, Cut 7, Meter 15, final part of Early Classic	34–8	1.6	1650–1350	250 (B)	
Uaxactún, Guatemala, 33–99–20/3393, scrap, Cache under plain Stela A–7. Morley estimates Maya date of 9.14.0.0.0	34–9	2.3			Disagreement unexplained at present.
"11.16" correlation A.D. 711			1248	450 (B)	
"12.9" correlation A.D. 452			1507		

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	*Sample Number*	*Hydration Layer Thickness in Microns*	*Archaeological Estimated Dates in Years B.P.*	*Obsidian Estimated Date in Years B.P.*	*Comment*
MAYA AREA — submitted by Gordon R. Willey, Peabody Museum, Harvard University (continued):					
Uaxactún, 33–99–20/3394, core, cache under plain Stela D–3, Morley estimated date 8.19.0.0.0	34–10	1.5			Disagreement unexplained at present.
"11.16" correlation A.D. 416 "12.9" correlation A.D. 157			1543 1802	200 (B)	
Uaxactún, 33–99–20/3402, adz, cache in top of E–IX, Early Classic (Tzakol) Period about A.D. 300–500	34–11	3.5	1650–1450	1100 (B)	
Uaxactún, 33–99–20/3413, scrap, cache under plain Stela D–3, Morley estimated date 8.19.0.0.0	34–12	2.3			
"11.16" correlation A.D. 416 "12.9" correlation A.D. 157			1543 1802	500 (B)	
Uaxactún, knife, Structure A–5, resembles pieces from Tikal with a 9.14.0.0.0 date, converted	34–13	3.1			
"11.16" correlation A.D. 711 "12.9" correlation A.D. 452			1248 1507	900 (B)	
Kaminaljuyú, Guatemala, 37–8–20/4835, knife, Miraflores phase, about A.D. 1	34–14	2.9	1950	750 (B)	
Kaminaljuyú, 38–83–20/6007, point, Mound I. Tomb III, Esperanza phase, A.D. 300–500	34–15	4.6	1650–1450	1900 (B)	Disagreement unexplained at present, but closer than some of other samples.
Kaminaljuyú, 38–83–20/6035, knife, Mound I, Tomb V, Esperanza phase, A.D. 300–500	34–17	5.1	1650–1450	2400 (B)	Disagreement unexplained at present.
Holmul, Guatemala, c/5466, scrap, Ruin B, Group II, with skeleton, Holmul III period (Early Classic) about A.D. 300–500	35–1	4.3	1650–1450	1700 (B)	Close agreement.
Tikal, Guatemala, 32–41–20/191, incised knife or scraper, found on dirt pile; believed to come from under Stela 16, dated at 9.14.0.0.0	35–2	0.74			Disagreement unexplained at present.
"11.16" correlation A.D. 711 "12.9" correlation A.D. 452			1248 1507	50 (B)	
Tikal, Guatemala, 32–41–20/191, incised knife or scraper, found on dirt pile; believed to come from under Stela 16, dated at 9.14.0.0.0	35–2 (repeat)	1.1			
"11.16" correlation A.D. 711 "12.9" correlation A.D. 452			1248 1507	100 (B)	
MEXICO (CHIAPAS) — submitted by Bertha P. Dutton, Museum of New Mexico					
Site T–6, Metapa on Rancho San José, south-					

"11.16" correlation A.D. 711					
"12.9" correlation A.D. 452			1248 1507	100 (B)	

MEXICO (CHIAPAS) — submitted by Bertha P. Dutton, Museum of New Mexico

Site T-6, Metapa on Rancho San José, southern extremity of Tapachula, Chiapas, Mexico. Bottom of north-south trench, 4II54, Dutton. Culturally dated by presence of Robles Plumbate pottery, about A.D. 750–1000 in other areas	47–4a	2.9	1250–950	760 (B)	Younger than the estimated age, but definitely a late site and may suggest that Robles Plumbate pottery has a more recent time span in this area. Additional samples of obsidian in direct association with this pottery in other sites would be interesting to test.
	47–4b	2.9	1250–950	760 (B)	
Same; north-south trench, center, Sack 9, Divided–1; 16II54, Dutton	47–5	2.6	1250–950	610 (B)	
Same; strata test 1, I–4, 4th level associated with sherds No. 306–336, 10II54, Dutton	47–6	1.7	1250–950	260 (B)	Extremely young age and discrepancy with other samples unexplained at present.

MEXICO — submitted by Gordon Ekholm, American Museum of Natural History

Aztec period obsidian mirror, about A.D. 1530, believed to be of about Conquest period	22–1	2.2	430	1100 (E)	Older than estimated. Possibly use of an older artifact by Aztecs; otherwise disagreement unexplained at present.
"Michoacán" obsidian mask, believed to be of modern manufacture and not authentic	22–2	No layer	Suspected as modern fake	Modern	Absence of any hydration rim suggests modern manufacture.

MEXICO (VALLEY OF MEXICO) — submitted by Ignacio Bernal, Instituto Nacional de Antropología e Historia, Mexico

Atepehuacán, about 9000 years B.P.	23–1	6.5	9000	9400 (E)	Reference point scale E.
Chicoloopan, Sample A, about 7000 years B.P. Level 0–25 cm.	23–2	5.0	7000	5600 (E)	Younger than estimated dates; either the culture has a longer history than estimated or might be from a more recent occupation of the same site.
Chicoloopan, Sample B, about 7000 years B.P.	23–3	5.6	7000	7000 (E)	Reference point scale E.
Chicoloopan, Surface, Aztec II period, A.D. 1250–1300	23–4a	2.4	700	1300 (E)	Older than predicted but since the sample is from surface, it might have been exposed to intense heating and the layer would be thicker than normal rate. Also definite association with Aztec II period is questionable as surface find.
Cuicuilco, Preclassic period, about 2700 B.P.	23–5a	2.5	2700	1400 (E)	Younger than estimated; might be from more recent occupations of area.
	23–5b	3.2	2700	2300 (E)	Close to estimated date considering that no good dates are from Cuicuilco.
Nexpayantla-Teotihuacán IV period, about 1200 B.P.	23–6a	2.2	1200	1100 (E)	Close to estimated date.
	23–6b	2.5	1200	1400 (E)	Slightly older than estimated but not too far off; disagreement not fully explained at present.
Modern, made in mid-November, 1958	23–7	No layer	Modern	Modern	Absence of any hydration rim suggests modern manufacture.

NEAR EAST — submitted by Ralph Solecki, Department of Anthropology, Columbia University

Shanidar Cave, Iraq. C–11, 3.00–3.25 m. below datum Cultural Layer B, radiocarbon date 12,400±400 (W–179)	6–2	8.9	12,000–12,800	12,000 (D)	Good agreement.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
NEAR EAST — submitted by Ralph Solecki, Department of Anthropology, Columbia University (continued):					
Same; Cut B–9 and Cut B–10, 2.75–3.00 m. below datum, Cultural Layer B, cut into top of Layer C.	6–3	15.0	12,000–12,800	35,000 (D)	Disagreement unexplained at present possibly re-use of older artifact.
Same; Cut B–11, 3.25–3.50 m., top of Layer C radiocarbon L–3354, 26,500±1500	6–4	11.3	25,000–28,000	20,000 (D)	Disagreement unexplained at present.
Same; Cut A–7, 2.75–3.00 cm., Layer C. Layer C ranges with radiocarbon dates from top with 26,500±1500 (L–3354) to the bottom of the Layer with dates ranging between 32,000±3000 (L–3351), 33,300±1000 (W–650), older than 34,000 (W–180), and 33,630 ±400 (DeVries), giving an average of 33,000 for the bottom of this cultural level	6–5	27.0	25,000–33,000	160,000 (D)	Old surface of obsidian unworked by occupants of cultural Layer C.
Same; Cut A–7, 2.75–3.00 m. deep; Layer C	6–7a	11.1	25,000–33,000	19,000 (D)	Disagreement unexplained at present.
Same; Cut A–7, 3.25–3.50 m. deep, bottom of Cultural Layer C	6–8	13.9	33,000	30,000 (D)	Disagreement unexplained at present unless it is not bottom of Layer C for otherwise the date is within the range.
	6–8a	10.1	33,000	16,000 (D)	Disagreement unexplained at present.
Same; Cut B–9, and B–10, 2.58–2.75 m. deep. Believed to be the top of Cultural Layer C.	6–9	9.5	25,000–28,000	14,000 (D)	Disagreement unexplained at present; unless artifact belongs to Layer B instead which would agree with the estimated dates.
Same; Cut C–9, 4.00–4.25 m., Layer C	6–11	10.3	25,000–33,000	16,000 (D)	Disagreement unexplained at present.
Shanidar Cave, Iraq, Cut 9, 2.75–3.00 m., bottom of Cultural Layer B or top of C	6–12	11.5	12,000–26,000	20,000 (D)	Agrees with top of Layer C radiocarbon dating.
Same; B–9, B–10, B–11, B–12, 1.80–2.40 m. Layer B intruded by Layer A, bottom of Layer A dates 10,600±300 (W–667) and bottom of Layer B dates 12,400±400 (W–179) so dates could fall in this range	6–13	8.6	10,600–12,400	11,000 (D)	Agrees with estimated range.
Same; Cut B–7, 1.75–2.25 m.; Layer B?	6–15	10.8	10,600–12,400	18,000 (D)	Disagreement unexplained at present.
Same; Cut X–7, 1.25–1.50 m.; top of Layer B or bottom of Layer A	6–16	9.1	10,600–12,400	13,000 (D)	Agrees with estimated range as Layer B.
Same; found while cleaning the north wall. Believed to be Layer B	6–17	5.4	10,600–12,400	4500 (D)	Suggests it could belong to Layer A of Neolithic to Recent rather than B.
Same; Cut 11, 1.75–2.00 m.; bottom of Layer A to top of Layer B	6–19 (burned)	13.0	10,600–12,400	26,000 (D)	Burning affected the "normal" rate of hydration so the age is not necessarily related to the cultural layer as shown by hydration layer thickness.
NEAR EAST — submitted by Robert J. Braidwood, Oriental Institute, Chicago			8250–9700		Obsidian burned; no rim visible.

tion so the age is not necessarily related to the cultural layer as shown by hydration layer thickness.

NEAR EAST — submitted by Robert J. Braidwood, Oriental Institute, Chicago

Jarmo, lower levels, probably date 7000±750 B.C. See *Science*, June 20, 1958. Whole Jarmo occupation from earliest —latest about 500 years	11–1 (burned)		8250–9700		Obsidian burned; no rim visible.
	11–2 (burned)	3.9	8250–9700		
	11–3 (burned)	5.9	8250–9700		
	11–4 (burned)	4.7	8250–9700		
Jarmo, upper levels, probably date 6750±750 B.C., *Science*, June 20, 1958	11–6 (burned)		7950–9450		Obsidian burned; hydration layer affected.
	11–7 (burned)		7950–9450		
	11–8 (burned)	5.6	7950–9450		
	11–9 (burned)	5.6	7950–9450		
Jarmo I 8, marked "O," Earliest Jarmo on virgin soil. Estimated dates 7000±750	11–20 (burned)		8250–9700		
Jarmo I 8, marked "Z," Earliest Jarmo on virgin soil	11–21	6.3	8250–9700	6200 (D)	Estimates younger than radiocarbon dates but closer to Braidwood's original guess dates of about 4750 B.C., or 6700 years B.P.
Jarmo I 6, marked "b," Early Jarmo	11–22	6.3	8250–9700	6200 (D)	
Jarmo I 6, marked "C," Early Jarmo	11–23 (approx.)	3.6	8250–9700	2000 (D)	Younger material that somehow found its way into excavation and probably not related to Early Jarmo level; otherwise unexplained at present.
Jarmo II 6, marked "H," Middle Jarmo 6750±750 B.C.	11–24	5.2	7950–9450	4200 (D)	Too young as compared to radiocarbon dates but closer to Braidwood's original guess dates of about 4750 B.C. or 6700, but even this does not agree; unexplained at present.
Jarmo II 6, marked "H," Middle Jarmo	11–25 (burned)		7950–9450		Obsidian burned, hydration layer affected.
Jarmo II 4, marked "4," Middle–Late Jarmo	11–26	5.6	7950–9450	4800 (D)	Too young; note comments for 11–24. Unexplained at present.
Jarmo II 4, marked "4," Middle–Late Jarmo	11–27	4.3	7950–9450	2900 (D)	Younger material that somehow found its way into level; otherwise unexplained at present.
Jarmo II–1 (m and n squared) Latest, in leaching and limestone formation zone.	11–28a–m (burned)		7950–9450		Obsidian burned; no hydration layers.
Amouq. Phase B, JK 3/21. Probable date 6000±500 B.C. with a single radiocarbon date on Mersin "Neolithic" which is equal to Amouq Phase A, based on sample W–617 (*Science*, June 20, 1958) 7950±250 B.P. Braidwood states this is a bit early, but perhaps not too much so	12–1	10.1	6950–7950 7700–8200	16,000 (D)	Since the specimen came from an excavated floor the great age as compared to the estimate cannot be explained at present. Exposure to sun for long periods before burial in the refuse might be an answer or re-use of older materials by this phase.
Same; JK 3/21	12–2	8.0	6950–7950 7700–8200	9900 (D)	
Same; JK 3/21	12–3	8.5	6950–7950 7700–8200	11,000 (D)	
Same; JK 3/22	12–4	11.0	6950–7950 7700–8200	19,000 (D)	
Same; JK 3/22	12–5	8.8	6950–7950 7700–8200	12,000 (D)	

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED):

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
NEAR EAST — submitted by Robert J. Braidwood, The Oriental Institute, Chicago (continued):					
Amouq. Phase B, JK 3/22. Probable date 6000 ± 500 B.C. with a single radiocarbon date on Mersin "Neolithic" which is equal to Amouq Phase A, based on sample W–617 (*Science*, June 20, 1958) 7950 ± 250 B.P. Braidwood states this is a bit early, but perhaps not too much so.	12–6	7.0	6950–7950 7700–8200	7700 (D)	Good agreement; the only one of the series from floors 21 and 22 of the same phase, that falls within predicted range.
Amouq. Phase E, KI, 2 m., Northwest Syrian-Ubaid variant, probable date about 3750 ± 300 B.C. Two single radiocarbon dates of pertinence. Tepe Gawra, Ubaid No. C–817 of 5400 ± 325 B.P. Warka basal (Ubaid) N–130/123) 6070 ± 160 B.P.	12–7	7.6	5400–6000 5075–5725 5910–6230	8900 (D)	Older than predicted; cannot be explained at present unless exposed to sun for long periods, or re-use of older materials.
Same; KI, 1 m.	12–8	8.8	5910–6230	12,000 (D)	
Same; KI, 3 m.	12–9	7.8	5910–6230	9300 (D)	
Same; KI, 3 m.	12–10	9.5	5910–6230	14,000 (D)	
Same; KI, 2.50 m.	12–11	5.1	5910–6230	4000 (D)	Younger than predicted; not explained at present.
Same; KI, 1.50 m.	12–12	7.0	5910–6230	7600 (D)	Older than predicted; cannot be explained at present. All the dates from 12–7 through 12–12 scatter so badly that at the present stage of the research no simple explanation can be given for the discrepancies. Possibly, re-use of older materials by this phase.
Matarrah VI–5, Basal Hassuna phase, compare with radiocarbon date for Sample 43–2, W–623 of 7570 ± 250 B.P.	42–1a	9.4	7320–7820	14,000 (D)	
	42–1b	9.0	7320–7820	12,000 (D)	Disagreement considerable; unable to explain unless sample had long years of exposure to hot sun before burial, or re-use of older materials.
Tabbat al-Hammam, TT–1, I–1. Typologically this horizon links with Amouq phases A–B and basal Mersin radiocarbon date (W–617) 7950 ± 250 B.P. But radiocarbon samples give (W–627) 6550 ± 200 B.P. and 7000 ± 80 B.P.	42–2a	10.1	6350–6750 6920–7080 7700–8200	16,000 (D)	
	42–2b	6.7	6350–6750 6920–7080 7700–8200	6900 (D)	Depending on which archaeological date you use the agreement is good to fair. Well within the range of dates.
Matarrah TT–1, I–2, High in the Hassunan phase, compare with radiocarbon date or (W–660) 7040 ± 200 B.P.	42–3a (burned slightly)	7.6	6840–7240	8900 (D)	Obsidian shows some burning which usually increases the hydration layer; this might explain the older age than estimated.
	42–3b	3.3	6840–7240	1700 (D)	Too young; either a younger specimen that somehow found its way into layer or unexplained at present.
	42–3c	8.4	6840–7240	11,000 (D)	Greater age than estimated unexplained at present unless object lay on surface for a considerable time before burial, or re-use of older materials.
Hassuna; surface find. Range Hassuna, Halaf and Ubaid periods. Compare radiocarbon date	42–4a	7.7	6840–7240 5450–7450	9100 (D)	Same; but not as far off as other samples.

Hassuna; surface find. Range Hassuna, Halaf and Ubaid periods. Compare radiocarbon date (W–660) 7040±200 B.P.; but this specimen might come from a range of only 5500–3500 B.C.	42–4a	7.7	6840–7240 5450–7450	9100 (D)	Same; but not as far off as other samples.
	42–4b	5.8	6840–7240 5450–7450	5200 (D)	Depending on which age estimate is used from archaeology the agreement is not too far off as compared to other samples.
Mersin, surface find. Picked up at basal levels in old strata cut and thus compare with radiocarbon date (W–617) 7950±250 B.P.; but may have fallen into cut from more recent levels	42–5a	10.7	7700–8200	18,000 (D)	Greater age than estimated, probably due to exposure to sun for long periods before burial or after deposit or re-use of older materials.
	42–5b	9.4	7700–8200	14,000 (D)	
Tepe Gawra, surface from long open exposures of old excavations. Range Ubaid–Gawran phases, Compare with radiocarbon (C–817) 5400±325 B.P., but 3800–3000 B.C. for this range is close estimate	42–6a	6.7	5075–5725 5750–4950	6900 (D)	Slightly older than estimated; this may be due to exposure to sun after excavation and before being picked up, or re-use of older artifact.
	42–6b	6.7	5075–5725 5750–4950	6900 (D)	
Grai Resh, surface from long open exposures of old excavations. Range Gawran phase (3400–3000 B.C.) to Ubaid phase (4000–3400 B.C.) but probably Gawran phase	42–7a	5.7	5350–4900 5950–5350	5000 (D)	Good agreement with Gawran phase.
	42–7b	5.4	5350–4900 5950–5350	4500 (D)	Younger than estimated dates; not explained at present.
	42–7c	3.5	5350–4900 5950–5350	1900 (D)	
Arpachiyah surface from long open exposures of old excavations. Range Halaf–Ubaid phases, estimated at 4800–3500 B.C.	43–1a (burned)	7.6	6750–5450	8900 (D)	Obsidian burned.
	43–1b (burned)	2.7	6750–5450	1100 (D)	
	43–1c	6.0	6750–5450	5500 (D)	Good agreement; within the range.
	43–1d	5.6	6750–5450	4800 (D)	Slightly younger; not explained at present.
Ali Agna, surface from long open exposures of old excavations. Compare with Matarrah VI–5. Radiocarbon date (W–623) 7570±250 B.P. Ali Agna is a one period site, earlier than Matarrah, probably Latest Jarmo or earliest Hasunan phase	43–2a	9.2	7320–7820	13,000 (D)	Obsidian burned.
	43–2b	9.6	7320–7820	14,000 (D)	
NEAR EAST — submitted by Frederick R. Matson, Pennsylvania State University					
Jarmo, surface collection. Late Jarmo phase estimated in radiocarbon range 6750±750 B.C. See details under samples 11–1 through 11–28	13–1 (burned)	5.1	7950–9450	4000 (D)	Obsidian burned; hydration rim affected. Dates too young for estimated range.
	13–2 (burned, abraded)	2.6	7950–9450	1000 (D)	Obsidian burned and abraded; hydration rim affected and worn off, thus age too young for hydration layer is not all there.
	13–3 (burned, abraded)		7950–9450		
Hassuna B; Hassuna phase as a whole dates by Braidwood's estimates 4800–6000 B.C.	13–4	7.5	6750–7950	8700 (D)	Slightly older than estimated, but not as far off as 13–6 or 13–7.
Hassuna C; same	13–6	8.9	6750–7950	12,000 (D)	Considerably older than estimated. If specimens were exposed to intense sun on surface at any time this might account for the thick hydration rim.
Hassuna F; same	13–7	6.2	6750–7950	5900 (D)	Younger than the estimated date, but lack of consistency between samples makes the discrepancies at this site difficult to explain at present.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
NEAR EAST — submitted by Frederick R. Matson, Pennsylvania State University (continued):					
Ur, Surface estimated approximately 3000 B.C.	13–9	8.0	5000	9800 (D)	Considerably older than estimated. If specimens were exposed to intense sun while on the surface this might explain the thick hydration layer.
Tell Uqair, Ubaid to Warka period, approximately 3600–3200 B.C.	13–10	8.9	5550–5150	12,000 (D)	
Arpachiyah, Ubaid Cemetery. Estimated to extend from about 6750–4950 B.C.	13–12 (burned)		7950–6900		Obsidian burned; hydration layer affected.
	13–14 (burned)		7950–6900		
	13–16 (burned)		7950–6900		
OHIO — submitted by Donald Collier, Chicago Natural History Museum					
Hopewell site, Mound No. 11, Ross County, Ohio unburned flakes from Workshop site. Hopewell culture estimated dates of around A.D. 1–500 with three radiocarbon dates (C–136) 1951±200 B.P. (C–139) 2044±250 B.P. and (C–137) 2285±210 B.P.	2–1a	3.9	1450–1950 1750–2150 1794–2294 2075–2495	3400 (E)	Older than any of estimates; unexplained at present.
	2–1b	3.0	2075–2495	2000 (E)	Reference point, scale E.
	2–1b (repeat)	3.0	2075–2495	2000 (E)	
	2–1c	3.0	2075–2495	2000 (E)	
OHIO — submitted by Raymond Baby, Ohio State Museum					
Mound City Group, Ross County, Ohio. Burial No. 1, Mound 13, Great Mica Grave, Hopewell Culture	2–2a	1.2	2075–2495	320 (E)	Too young; probably modern breakage in no way related to Hopewell culture.
	2–2b	3.7	2075–2495	3000 (E)	Older than any of estimates; unexplained at present.
	2–2c	1.3	2075–2495	380 (E)	Too young; probably breakage in no way related to Hopewell Culture.
	2–2d	2.8	2075–2495	1700 (E)	Good agreement; within the range.
Same; except piece burned and split but split surface looks clean without crackled lines	2–2e	3.3	2075–2495	2400 (E)	Near upper end of range of Hopewell dates.
Hopewell Mound No. 25, Ross County, Ohio. Large cache. Some burned but only unburned specimens picked out	2–3a	3.2	2075–2495	2300 (E)	Good agreement, within the range.
	2–3b	3.0	2075–2495	2000 (E)	Reference point; scale E.
	2–3c	3.2	2075–2495	2300 (E)	Good agreement; within the range.
	2–3d	3.0	2075–2495	2000 (E)	Reference point; scale E.
	2–3e	3.6	2075–2495	2900 (E)	Older than estimates; unexplained at present.
	2–3f	3.3	2075–2495	2400 (E)	Near upper end of range of Hopewell dates.
Hopewell Mound No. 25, Ross County, Ohio. Large cache. Some burned, but unburned specimens picked out for study. Dates for Hopewell culture outlined in detail in Sample 2–1a.	2–3g	3.7	1450–1950 1750–2050 1794–2294 2075–2495	3000 (E)	Older than any of estimates; unexplained at present.
Hopewell Mound No. 25, Ross County, Ohio. Large cache. Some burned, but unburned speci-	2–3h	3.0	2075–2495	2000 (E)	Reference point, scale E.
	2–3i	2.9	2075–2495	1900 (E)	Good agreement; within the range.

Hopewell Mound No. 25, Ross County, Ohio. Large cache. Some burned, but unburned specimens picked out for study. Dates for Hopewell culture outlined in detail in Sample 2–1a.	2–3h	3.0	2075–2495	2000 (E)	Reference point, scale E.
	2–3i	2.9	2075–2495	1900 (E)	Good agreement; within the range.
	2–3j	3.1	2075–2495	2100 (E)	Near the upper end of Hopewell dates.
	2–3k	2.9	2075–2495	1900 (E)	Good agreement; within the range.
Mound City Group, Ross County, Ohio. Mound No. 13, Deposit 5, 260/68	2–4	3.9	2075–2495	3400 (E)	Older than any of estimates; unexplained at present.
Seip Group, Ohio, Burial No. 58, 429F	2–5	3.0	2075–2495	2000 (E)	Reference point, scale E.
Seip Group, Ohio. No other data	2–6a	5.2	2075–2495	6000 (E)	Older than any of estimates; unexplained at present; possibly the thin section is through an old natural surface.
Fort Hill, Highland County, Ohio. Fragment of blade from post hole	2–7	5.7	2075–2495	7200 (E)	
OREGON — submitted by L. S. Cressman, Department of Anthropology, University of Oregon					
Five-Mile Rapid site, Level 31, Road Cut site. Stratum approximately 2.5 m. deep. Specimens from cache in top 20 cm. Radiocarbon dates from campsite materials assembled from the whole stratum. 9785 ± 220 B.P.; Cat. No. WS 4RI; F29–12–31	51–1	6.0	9565–10,005	5500 (D) 8000 (E)	The hydration rate for this area is not determined; hence both scales are shown. Date from scale E is not too far from estimate. Since specimens are from the cache in upper 20 cm., the younger age might be accurate, because the cache could have been placed in the stratum at some time after the deposition of the material from which the radiocarbon date came.
Same; Cat. No. WS 4RI; F 29–12–31	51–2	6.1	9565–10,005	5700 (D) 8200 (E)	
Same; Cat. No. WS 4	51–5a	5.9	9565–10,005	5300 (D) 7700 (E)	
	51–5b	6.0	9565–10,005	5500 (D) 8000 (E)	
	51–5c	5.7	9565–10,005	5000 (D) 7200 (E)	
	51–5d	5.7	9565–10,005	5000 (D) 7200 (E)	
	51–5e	6.0	9565–10,005	5000 (D) 7200 (E)	Same. In spite of the lack of close conformity of hydration layer dates and estimated dates, all samples from this site are fairly consistent. Possibly a better rate of hydration can be established for this zone that will clarify some of these discrepancies.
Paisley Five-mile point, Cave No. 1. Sample No. 1–8975. Earlier than Mt. Mazama eruption; could be as old as Sample 51–3, but probably younger	51–4	5.0	7500–12,000	3800 (D) 5500 (E)	Regardless of what scale is used the dates from obsidian are younger than eruption of Mt. Mazama, as predicted.
Paisley Five-mile point, Cave No. 3. Sample No. X. Earlier than Mt. Mazama eruption and in direct association with horse, camel, bison, mountain sheep. Cressman on basis of geological and archaeological evidence estimates 10,000± a few centuries. Radiocarbon date of Mt. Mazama eruption (Y–109) 7610 ± 120 B.P.	51–3	6.5	7500–10,000	6500 (D) 9400 (E)	Within the estimated range if scale E is used. In the light of all the other dates from samples in the cave there is a scattering of dates that suggests that Cave 3 was occupied over a longer period of time than estimated.
	51–6a	6.7	7500–10,000	6900 (D) 10,000 (E)	

TABLE I. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	Sample Number	Hydration Layer Thickness in Microns	Archaeological Estimated Dates in Years B.P.	Obsidian Estimated Date in Years B.P.	Comment
OREGON — submitted by L. S. Cressman, Department of Anthropology, University of Oregon (continued):					
Paisley Five-mile point, Cave No. 3, Sample No. X. Earlier than Mt. Mazama eruption and in direct association with horse, camel, bison, mountain sheep. Cressman on basis of geological and archaeological evidence estimates 10,000± a few centuries. Radiocarbon date of Mt. Mazama eruption (Y–109) 7610±120 B.P. Cat. No. 1–10362	51–6b	4.6	7500–10,000	3300 (D) 4700 (E)	Younger than any of the estimated dates.
	51–6c	7.2	7500–10,000	8000 (D) 12,000 (E)	Thickest hydration layer from Cave No. 3. Might date the oldest occupation of cave; scale D gives a date close to estimate.
	51–6d	5.2	7500–10,000	4200 (D) 6000 (E)	Younger than any of estimated dates.
Same; Cat. No. 1–10363	51–6e	4.9	7500–10,000	3700 (D) 5300 (E)	Younger than any of estimated dates.
SOUTHWEST UNITED STATES (COLORADO, ARIZONA, NEW MEXICO) —					
ARIZONA — submitted by Edward B. Danson, Museum of Northern Arizona, Flagstaff					
Obsidian from NA 1925B (Sinagua by H. S. Colton, 1946: 160) nine tree beams; two dated by Douglass as A.D. 833, 859; and by Mc.Gregor as A.D. 840 and 855, thus giving an average of A.D. 860 as building date. Sunset focus of the Sinagua and Coconino focus of the Cohonina with ceramic dates A.D. 700–900	16–1	5.1	1100 1250–1050	4000 (D)	Older than estimated; unable to explain at present unless re-use of an older artifact is possible. Exposure to sun during history of burial of object may account for thick hydration layer.
ARIZONA — submitted by Emil W. Haury, Arizona State Museum					
Ariz. W:10:78 (Turkey Creek site), Point of Pines, Reserve-Tularosa phase transition, about A.D. 1100–1200, surface material	16–2b	2.9	850–750	1300 (D)	Older than estimated. Surface specimen might have had intense exposure to sun which makes the hydration develop faster than in normal burial conditions, possibly re-use of older artifact.
	16–2c	0.98	850–750	150 (D)	Younger than estimated; might be of recent, non-archaeological context.
Ariz. W:10:50 (Point of Pines ruin), Room 109, Level II, 1.5–1.9 m.; about A.D. 1300	16–3a	1.4	650	300 (D)	Younger than estimated; unexplained at present.
	16–3b	1.1	650	200 (D)	
Ariz. W:10:112 (Cienega site), Point of Pines, Layer C. Radiocarbon dates: Michigan, 900 B.P.; Univ. of Arizona, 2500 B.P.	17–1	1.2	900	220 (D)	Younger than estimated; unexplained.
	17–1 (repeat)	1.5	2500	300 (D)	
Same; Layer D. Radiocarbon dates: Michigan, 2500 B.P.; Arizona, 4000 B.P.	17–2a	3.6	2500 4000	2000 (D)	Not as old as estimated by either radiocarbon date; unexplained at present.
	17–2b	1.6	4000	390 (D)	
	17–2c	2.5	4000	960 (D)	
Ariz. Z:2:1, Gila Bend site, Arizona, Sedentary Hohokam period, of about A.D. 1100	17–3a	3.6	850	2000 (D)	Older than the estimated dates; possible exposure to hot sun might have increased the rate of hydration, possibly re-use of older artifact.
	17–3b	4.5	850	3100 (D)	
	17–3d	5.5	850	4700 (D)	
COLORADO — submitted by Frank H. H. Roberts, Bureau of American Ethnology					

Hohokam period, of about A.D. 1100	17–3d	5.5	850	4700 (D)	of hydration, possibly re-use of older artifact.

COLORADO — submitted by Frank H. H. Roberts, Bureau of American Ethnology

Lindenmeier site, Colo. Folsom Points of obsidian, radiocarbon on sample No. C–451, "charcoal obtained from a hearth in the fill of a secondary channel. Geological evidence indicated that the age of the hearth should be approximately half that of the occupational level from which the Folsom materials were taken": 5020±300 B.P. thus giving a guess date of about 10,000 years B.P.	9–1	5.9	4720–5320 10,000	5400 (D)	Agrees with the radiocarbon sample but not the estimated date of the cultural deposit; discrepancy unexplained at present.
	9–2	5.6	4720–5320 10,000	4900 (D)	
	9–3	5.8	4720–5320 10,000	5200 (D)	Same; agreement of three samples close, however.

MESA VERDE, COLORADO — submitted by Mrs. Jean M. Pinkley, Mesa Verde National Park, Colorado

Flake from Pipe Shrine House, Mesa Verde, dated at around A.D. 1000–1200	24–1	3.7	950–750	2100 (D)	Older than estimated dates; either re-use of older artifact or exposed to sun for long periods; otherwise the disagreement is unexplained at present.
	24–2	2.8	950–750	1200 (D)	Same; but not too far from estimates.
Falls Creek Cave, Basketmaker II, North Shelter, tree-ring dates of A.D. 197	24–3	3.1	1762	1500 (D)	Younger than estimates, but not so far out of line as compared to other samples.
	24–4	3.3	1762	1700 (D)	Very close to estimated dates.
Site 103, Mesa Verde, Pueblo I period from floor pit in pit room 2–c, tree-ring dates A.D. 832–845	24–5 (poor obsidian)		1127–1114		
Mound debris of Site 34, Mesa Verde, with bark dates from 1098 through 1180 of roof timbers	24–6	2.0	861–679	590 (D)	Close agreement with estimated date.
Scraper from Site 103, westernmost slab room; Pueblo I; tree-ring dates A.D. 812 through 844	24–8	3.9	1147–1115	2300 (D)	Older than estimates; either re-use of older artifacts or exposed to sun for long periods; otherwise the disagreement is unexplained at present.
	24–8 (repeat)	4.0	1147–1115	2500 (D)	

NEW MEXICO — submitted by John P. Miller

Tesuque, New Mexico. Radiocarbon dates 2230 B.P.	8–1	2.2	2230	750 (D)	Younger than estimated; either the artifact is not related to the radiocarbon date or it might be of recent occupation. Discrepancy not explained at present.

NEW MEXICO — submitted by Fred Wendorf, Museum of New Mexico, Santa Fe

Pine Creek H.W.S. (LA 3639), Room 8, Floor, Stratigraphically below Room 6, about A.D. 950	33–1	2.3	1000	820 (D)	Younger than the estimates; unexplained at present.
Pine Creek H.W.S. (LA 3639), Room 6, Level 3. Above Room 8 and equal to or earlier than Room 4, about A.D. 1000–1050	33–2	3.1	950–900	1500 (D)	Older than estimates; possibly exposure to intense sun might have sped up hydration rate; otherwise unexplained at present, possibly re-use of older artifact.
Same; Room 4, about A.D. 1000–1050	33–3	5.8	950–900	5200 (D)	Considerably older than estimates; possibly exposure to intense sun might have sped up hydration rate over normal one for burial in ground, possibly re-use of older artifacts.

TABLE 1. DATA ON ALL OBSIDIAN SAMPLES INCLUDED IN THE PRELIMINARY ANALYSIS (CONTINUED)

Provenience	*Sample Number*	*Hydration Layer Thickness in Microns*	*Archaeological Estimated Dates in Years B.P.*	*Obsidian Estimated Date in Years B.P.*	*Comment*
NEW MEXICO — submitted by Fred Wendorf, Museum of New Mexico, Santa Fe (continued):					
San Mateo H.W.S., Site No. 8 (LA 3568), Pit house No. 1, floor plus 6 inches, about A.D. 950	33–4	2.3	1000	820 (D)	Younger than estimates; unexplained at present. Possibly of some significance that Samples 33–1 and 33–4 with the same estimated dates give similar obsidian dates, and these only 200 years off the estimate.
Tesuque By-Pass site (LA 3297), Hearth 20 inches below top of No. 1 fill, radiocarbon date 2230±250 B.P.	33–5a	1.8	1980–2480	500 (D)	Considerably younger than estimates; unexplained at present.
	33–5b	1.3	1980–2480	260 (D)	
Same; (LA 3297), Middle Layer, 25–35 inches from top	33–6a	2.0	1980–2480	620 (D)	
	33–6b	1.6	1980–2480	390 (D)	
Pindi Pueblo, Early Period A.D. 1250–1300	33–7b	4.1	700–650	2600 (D)	Older than estimates; possibly exposure to intense sun might have sped up hydration, possibly re-use of older artifact.
	33–7c	3.3	700–750	1700 (D)	
Navajo Project, Site 90 (LA 3427), Feature 1, refuse from pit house, about A.D. 750–800	33–9	3.3	1200–1150	1700 (D)	Older than estimates; re-use of older artifact or possibly exposure to sun before burial.
Same; Site 90 (LA 3427), Feature 3, Lower Level of pit house fill, about A.D. 850–900	33–10	2.1	1100–1050	690 (D)	Younger than estimates; unexplained.
Same; Site 90 (LA 3427), Feature 3, Upper Level of fill, about A.D. 900–950	33–11b	3.3	1050–1000	1700 (D)	Older than estimates; possibly exposure to intense sun as a surface specimen before burial, possibly re-use of older artifact.
UTAH — submitted by Jesse D. Jennings, University of Utah					
Danger Cave, Utah, Layer II; dates of occupation rounded off to 8500–9000 B.P. (See *SAA Memoir*, No. 14: 93–8.); radiocarbon date (C–640) 8960±340 B.P. (7010 B.C.)	4–1a	7.2	8500–9000	8000 (D)	Point of reference in plot of scale D.
	4–1b	7.7	8500–9000	9100 (D)	
UTAH — submitted by Mr. Earl Stoddard through Waldo R. Wedel, United States National Museum					
Projectile points from Fremont Island site, Great Salt Lake, Utah, 4 miles south of Promontory Point in Lake. Artifacts and cultural associations described in detail in *American Antiquity*, Jan. 1954, pp. 285–90. Occupied during preceramic periods of Utah, with possibly one Pueboid type culture. Dates 2000 to 10,000 years ago. (All specimens used are non-sandblasted)	46–1	4.1	2000–10,000	2600 (D)	Within the range.
	46–2	4.7	2000–10,000	3400 (D)	
	46–3	4.5	2000–10,000	3100 (D)	
	46–4	4.0	2000–10,000	2500 (D)	
	46–5	5.3	2000–10,000	4300 (D)	
	46–6	9.0	2000–10,000	13,000 (D)	Close to estimated range.
	46–7	8.5	2000–10,000	11,000 (D)	
	46–8	5.9	2000–10,000	5400 (D)	Within the range.
	46–9	3.2	2000–10,000	1600 (D)	Younger than predicted. Section made across a well chipped area and not a recent break.
	46–11	4.1	2000–10,000	2600 (D)	Within the range.
	46–14	6.0	2000–10,000	5500 (D)	
	46–15	5.4	2000–10,000	4500 (D)	

A NEW DATING METHOD USING OBSIDIAN: PART II, AN ARCHAEOLOGICAL EVALUATION OF THE METHOD *

CLIFFORD EVANS AND BETTY J. MEGGERS

ABSTRACT

Dating archaeological sites, cultures or phases by the obsidian method is still experimental, but shows promise provided the archaeologists understand the present limitations. Two categories of factors cause possible dating errors: the technical or geological aspect discussed by Friedman and Smith, and the archaeological context. For the establishment of valid rates of hydration and for the archaeological evaluation of the method, preferred samples are those datable by independent means, such as radiocarbon, dendrochronology, historical records, rates of refuse accumulation, contemporary calendars, or correlated positively with complexes or seriated sequences that are so dated. A few samples used in the preliminary part of the study do not meet these rigid standards and make the method look poorer than it is, but a table contains the raw data on all specimens tested to date. The principal source of potential error at our present state of knowledge is the frequency with which artifacts of older manufacture were re-used by a younger (more recent) culture. Evaluations of the data presented in the table and most of the results are discussed by geographical area. For the tropical region where the annual temperature range is minimal and where large obsidian samples from village refuse are available, the hydration rate appears to be a fairly accurate method of dating. Lack of conformity of obsidian dates with archaeological dates for the Maya region and the Southwest, however, emphasizes the need for further research using larger series of artifacts and for a continued examination of technical factors. Objects of modern manufacture can be identified with little difficulty, offering a simple means of detecting fakes or copies.

SINCE ONE of the major goals of archaeology is the reconstruction of history, dating constitutes one of its major problems. The paramount importance of dating has tempted archaeologists to seize upon new techniques of arriving at so-called "absolute" dates before these have been adequately tested and evaluated. In order to avoid premature acceptance of the possible method of dating by using obsidian, we wish to emphasize its *experimental* nature at the present time. Careful reading of Friedman and Smith's paper, our discussion, and Table 1 will make it clear that numerous pitfalls lie in the path of an uncritical user at the present stage of the research. Indeed, the unsolved problems are sufficiently numerous and varied that the value of publishing a statement on the method at this time can be questioned. Refinement of the method and an understanding of its limitations for dating archaeological remains depend, however, upon continued extensive cooperation from the archaeological profession. Thus, this discussion is offered as an informational and progress report.

Two separate categories of factors causing possible dating error must be considered in making archaeological evaluations of dated obsidian specimens. One category might be termed the technical aspect. This has been discussed at length by Friedman and Smith, who describe the physical and chemical variables that may alter the hydration rate. Some of these appear to have a negligible effect; others are very significant in determining rates of hydration for specific geographical areas. While laboratory experiments can be designed to assess some of the variables, others are most readily approached through the analysis of selected archaeological material. The ability to evaluate the results in the latter case depends largely on the reliability of the archaeological associations.

The second major category of factors producing possible dating error derives from the archaeological situation. Unfortunately, the magnitude of this category was not foreseen in the early stages of the research, with the consequence that a large number of samples were cut and measured without sufficiently exact accompanying archaeological information. Now, we realize that for the development of the method as a possible dating device, no sample should have been utilized that could not be dated directly by radiocarbon, dendrochronology, historical records, rates of refuse accumulation, contemporary calendars (such as Maya, Egyptian), or be correlated positively with complexes or seriated sequences that were so dated. Samples whose guess dates span several thousands of years, as is the case with the Denbigh Flint complex artifacts of Alaska, cannot be employed for determining the hydration rate applicable to an area. A number of samples

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from surface collections were measured before the effect of temperature was sufficiently understood, and it was recognized that exposure of the black obsidian to excess solar radiation could distort the "normal" hydration rate. The fact that a sample has been subjected to this source of distortion is not always evident a priori because it may have been exposed for long periods at some time during the past and subsequently buried, so that its present archaeological context would appear to make it suitable for dating.

The principal source of potential error at our present state of knowledge in the research project is the re-use of artifacts of older manufacture. Generally, this situation has been given little consideration in archaeological interpretation, largely perhaps because of inadequate evidence of its existence. Re-use appears to be particularly common where the artifacts are simple chips or prismatic flakes used as blades or scrapers, as is common on the coast of Ecuador, rather than shaped objects such as projectile points. The fact that re-use of older objects can be conclusively demonstrated in some archaeological complexes makes it essential to consider this as a possible explanation in other situations where the obsidian date is considerably older than the expected date of the cultural horizon from which the artifact was removed. Fortunately, the re-use of artifacts can be recognized and the specimens of contemporary manufacture can be singled out provided that (1) a sufficient number of samples is measured from each level of stratigraphic excavations, and (2) a seriated sequence of sites and cultural complexes has been worked out in detail for the region. At the time this research program began, the only obsidian material readily available in great quantities in the collections of nearby museums for testing that suited these two qualifications was that from coastal Ecuador. Similar large samples from sequences in other parts of the world would undoubtedly permit the resolution of many of the discrepancies that now appear between obsidian dates and estimated archaeological dates. However, the apparent predominance of the re-use of certain types of artifacts in some cultures suggests that single specimens cannot be relied upon to produce a valid date for a site, complex, or phase.

It is essential to recognize from the beginning of the discussion that the archaeological problem is separate from the technical one. Even if all the variables influencing the rate of formation of the hydration layer become clearly understood, the question of the reliability of the method for dating archaeological sites, complexes, or phases still remains. If the date is assumed to be accurate, it still applies directly only to the artifact whose hydration layer is measured. This artifact may be contemporary with the rest of the deposit, in which case its date is representative of the site. However, it may instead be an older object picked up, reused without reshaping or chipping, and redeposited, or it may be a more recent specimen accidentally associated with earlier refuse. If these possibilities cannot be evaluated, an obsidian date cannot be used for archaeological interpretation.

Information on all samples measured so far is contained in Table 1, including sample number, the thickness of the hydration layer in microns, provenience and comments by the contributor, the estimated archaeological date, the obsidian date calculated from the tentative hydration rate established for that area, and an evaluation of the validity of the obsidian date. The obsidian dates are subject to a plus or minus error of measurement technique that is currently in the order of 0.1 to 0.2 micron, but at this preliminary stage of the research the error has not been converted into years. To emphasize their approximate nature, the dates have been rounded off to the nearest two significant figures. It must be emphasized that the obsidian dates, where they disagree with dates derived from other information, are not necessarily to be relied upon. To consider the conversion of hydration layer thicknesses into calendar dates or years B.P. as anything more than *tentative* and *experimental* would be unrealistic in the present stage of the development of the method.

Obsidian artifacts have been examined from most parts of the world where this type of rock material was used by man. While all of the samples measured to date are shown in Table 1, only those that present particular problems or illustrate the potential contribution that this possible dating method can make in archaeology are discussed in this paper. Following these comments, other types of evidence of archaeological interest that can be obtained from analysis of obsidian artifacts are mentioned.

VALLEY OF MEXICO

The samples from the Valley of Mexico when plotted against the hydration rate of Temperate Scale E (Fig. 17) fall in line quite closely with the estimated dates. These artifacts date as follows: Sample 23–1, Atepehuacán, with an estimated date of 9000 years B.P., gave an obsidian date of 9400 years B.P.; Sample 23–3, Chicoloopan Sample B, with an estimated date of 7000 years B.P., dated 7000 years B.P. by obsidian; Samples 23–6a and 23–6b, Nexpayantla, Teotihuacán IV period, with an estimated date of 1200 years B.P., gave two slightly different obsidian dates of 1100 years B.P. and 1400 years B.P.; and Sample 23–7, the two modern arrowheads manufactured for the experiment in mid-November, 1958, showed no hydration layer confirming their modern date.

Three other samples did not agree so closely. Sample 23–2, Chicoloopan Sample A, estimated at 7000 years B.P., gave only 5600 years B.P. by obsidian. Since Sample B from the same site appears to give a correct date, several explanations for this lack of agreement are suggested: (1) Chicoloopan Samples A and B may not be associated with exactly the same cultural level; (2) the Sample A date may also be correct and the cultural period at the site may have had a longer life span than has been suspected, or (3) another culture occupied the site following the occupancy that had produced Sample B and the types of artifacts or conditions of discovery did not permit a distinction of the two samples at the time, and thus Sample A dates this more recent occupation. These are the types of questions that must be asked about a specimen to pin down its exact archaeological association before final evaluation can be made of the obsidian method.

Sample 23–4a, an artifact from the surface of the Chicoloopan site, stated to be from the Aztec II period with an estimated date of about 650–700 years B.P., gave an obsidian date of 1300 years B.P. There are several possible explanations for this discrepancy: (1) an older artifact was picked up, re-used and discarded in the refuse without any rechipping; (2) obsidian samples exposed on the surface in areas of intense solar radiation may have their rate of hydration speeded up as compared to the "normal" rate of hydration of buried samples for this area; and (3) the identification of this surface artifact as belonging to the Aztec II period is very tenuous. Samples 23–5a and 23–5b are from the Preclassic period at Cuicuilco with an estimated date of 2700 years B.P. The obsidian date for Sample 23–5a is 1400 years B.P. and for 23–5b, 2300 years B.P. The date for Sample 23–5b is within reason because the duration of the Preclassic period at Cuicuilco is not as yet so firmly established that a difference of only 400 years can be considered a serious conflict. The other sample, 23–5a, which dates younger, is an artifact of non-distinctive characteristics that could easily be associated with the later Aztec occupation in the area. If a large series of samples from this site were measured, this possibility of later occupation of the same site could be more adequately evaluated. Thus, in terms of the limited samples tested to date from the Valley of Mexico, it appears as if Temperate Rate E is a fairly valid one for the region. However, additional experimental work on a larger series of specimens, especially including large series of flakes and chips from village refuse, is necessary before this conclusion can be considered confirmed.

Before leaving the Valley of Mexico it might be well to comment on two other specimens submitted by Gordon Ekholm. Sample 22–2 is a so-called "Michoacán" obsidian mask believed to be fraudulent and of modern manufacture. This gave no evidence of a hydration layer and can thus be classified as modern, verifying the archaeologist's suspicions. Sample 22–1 is an Aztec obsidian mirror dated at about 430 years B.P. (A.D. 1530) because these objects are believed to fall at the end of the Aztec period and the beginning of the Spanish Colonial period, when they were used as church ornaments. The obsidian hydration layer of 2.2 microns gives a date of 1100 years B.P., which does not coincide very well with the estimated dates. Although there might be variable factors in the hydration of this specimen that are not known, certain questions about the archaeological associations must be answered before the obsidian date can be ruled out. First, the assignment of the piece to the late Aztec or early Spanish Colonial period is not fixed information, although the Spanish chroniclers mention the use of obsidian mirrors. It is well known that the Aztec civilization is one that organized many peoples and states into its political control, and that some of these groups had a long history. Could the obsidian mirror be an heirloom or important ceremonial object handed

down from one generation to another, or passed from an earlier civilization, such as Toltec or Teotihuacán, to the Aztec? It is far easier to visualize the passing on from one generation to another or from one culture to another a beautifully-made object, such as a large obsidian mirror, than an obsidian projectile point or flake blade; therefore, this possibility must be investigated further, and if possible, more obsidian mirrors from Mexico should be tested in order to resolve the problem. Obsidian from well-dated Colonial contexts in Mexico should help to establish a more accurate rate of hydration for the area.

Coastal Ecuador

The largest series of samples so far examined from a single site comes from R–B–1, Chorrera, a habitation refuse deposit on the Río Babahoyo, Guayas Province, coastal Ecuador (Evans and Meggers 1957). Measurements made by Friedman and Smith of the hydration layer of 62 thin sections, or one to four specimens per level from Cut 1 (Table 1, 1–2 through 1–27) caused them to subdivide the excavated layers of refuse into several segments based upon variations in thickness. They noted that Samples 1–21 through 1–27, representing those levels below 2.85 m. included no hydration layers thinner than 5.2 microns, with the majority measuring 5.8 microns or more (Fig. 18). Levels from 2.85 m. to the top of the cut, which includes Samples 1–2 through 1–20, often had specimens with hydration layers as thin as 2.9 to 3.0 microns. In most of these levels there were also obsidian specimens with hydration layers up to 6.4 microns, while Level 45–60 cm. (Sample 1–5A) and Level 0–15 cm. (Sample 1–2B) produced specimens with hydration layers measuring 1.6 and 0.97 microns, respectively.

Friedman and Smith interpreted these data from R–B–1, Cut 1 as follows. First, they felt that the two samples that measured less than 2.0 microns could, in view of their thinness, be classified as "modern." In reviewing the data, we concur; this region has been important agriculturally from the time of the first Spanish occupation, and in recent times the site has been occupied by a banana plantation. Obsid-

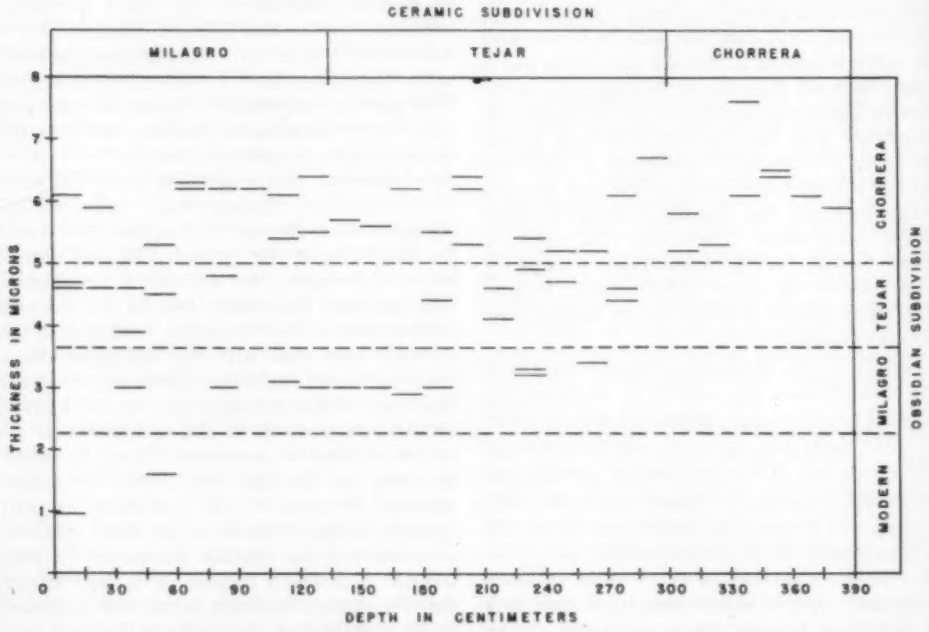

Fig. 18. The thickness of the hydration layers of the obsidian artifacts from various levels in Cut 1, Site R–B–1, Chorrera, on the coast of Ecuador. The cultural divisions derive from pottery classification and the levels at which they subdivide are shown at the top. The divisions suggested by differences in thickness of the hydration layers of the obsidian artifacts are shown at the right.

ian dates of 86 years B.P. and 230 years B.P. for Samples 1–2B and 1–5A would easily fit into this recent period.

Friedman and Smith's second observation was that the thinnest rims above the 2.85 m. depth, excluding the "modern" samples, seemed to fall into two general groups, one from 2.9 to 3.9 microns in thickness and another from 3.9 to 4.9 microns. Since no obsidian from levels below 2.85 m. produced any hydration layers as thin as 5.0 microns, they concluded that hydration layers from 2.9 to 4.9 microns in thickness denoted flakes, chips and artifacts that had been manufactured by the people who lived at the site subsequent to the first occupation. All the obsidian having a hydration layer thicker than 5 microns that occurred in these same levels could be interpreted as re-use and redeposition of older material.

When the thicknesses were converted into years according to the hydration rate of Scale B (Fig. 17), they gave the following dates: The earliest occupation from 2.85 m. to the bottom of the cut gives a minimum of 2500 years B.P. (Sample 1–22A) and a maximum of 5300 years B.P. (Sample 1–24B), which is probably an old surface and not related to the Chorrera period. The majority of the specimens from these levels fall between 3100 and 3400 years B.P. The next group thought by Friedman and Smith to be possibly significant was that with hydration layers measuring between 3.9 and 4.9 microns, giving dates between 1400 and 2200 years B.P. The most recent group, with hydration layers of 2.9 to 3.9 microns, dates from 760 to 1400 years B.P. The practice of re-using obsidian flake blades and scrapers from the earlier refuse is indicated by the continuing presence of artifacts with hydration layers of maximum thickness throughout the refuse deposit, thus making it necessary to focus attention on the youngest specimens representing each level (Fig. 18).

At this point the data were turned over to us for evaluation, analysis, and interpretation in terms of the archaeological situation, of which the geologists had no knowledge during the measurements. On the basis of changes in the pottery types, the refuse deposit of R–B–1 had been subdivided into three parts: the Milagro period, from 0 to 1.35 m.; the Tejar period, from 1.35 to 3.00 m.; the Chorrera period from 3.00 m. to the bottom of the stratigraphic cut. The Chorrera period refuse coincides almost exactly with the earliest period distinguished by the geologists, but there is no clear natural separation in the thickness of hydration layers at 1.35 m. that correlates with the Tejar-Milagro period subdivisions. However, the intermediate grouping of artifacts with hydration layers of 3.9 to 4.9 microns thickness gives a date that would be acceptable for the Tejar period, and the third group, with thicknesses of 2.9 to 3.9 microns, undoubtedly represents the Milagro period. If this interpretation is valid, then the artifacts, flakes, and chips of obsidian with hydration layers less than 3.9 microns in thickness in levels below 1.35 m. may be explained as mechanical mixture, either during occupation of the site, afterwards by rodent and small animal burrowing, or from accidental falling into the excavation of a specimen from an upper level in the walls of the stratigraphic cut.

The frequency of re-used material, which associates early objects with late levels, and the possibility of disturbance, which can move late material into earlier levels in habitation refuse, are two problems that the Chorrera stratigraphic excavation illustrates in an extreme way. The fact that the artifacts are chips or prismatic flakes used as blades or scrapers without shaping beyond the initial blows striking them from a core, rather than projectile points or carefully shaped artifacts, probably accounts for this extensive re-use. Comparable re-use might be predicted in other areas with similar rudimentary obsidian tools. However, with adequate knowledge of the cultural sequence and a sufficient number of samples per level, re-used objects can be readily distinguished from those of contemporary manufacture. Artifacts of too recent date can be recognized if a series of samples is secured for several sites of the same cultural period, and if the cultural sequence in the area is sufficiently well known. A good relative chronology is essential for evaluation of any absolute dates, whether they are derived from obsidian, radiocarbon, dendrochronology, or some other method.

Because temperature appears to be the most important climatic factor in altering the hydration rate, it was desirable to undertake an intensive analysis of the archaeology of a restricted area, where the annual range of temperature is very small and the time period is short enough to avoid the problem of major climatic changes. Since a large series of obsidian sam-

ples was available from coastal Ecuador, and the cultural sequence had been worked out in considerable detail, this area was chosen. Fifteen habitation sites, covering all the archaeological periods except the earliest, in which obsidian was not used, were studied. The majority of the sites was represented by stratigraphic excavations and up to ten specimens per level were measured. Independently of the obsidian analysis, the cultures were arranged on the basis of stratigraphic superposition and pottery type seriation in the order shown in Figure 19. Measurements of 122 thin sections are listed in Table 1 (Samples 1–2 through 1–27, 27–1 through 27–

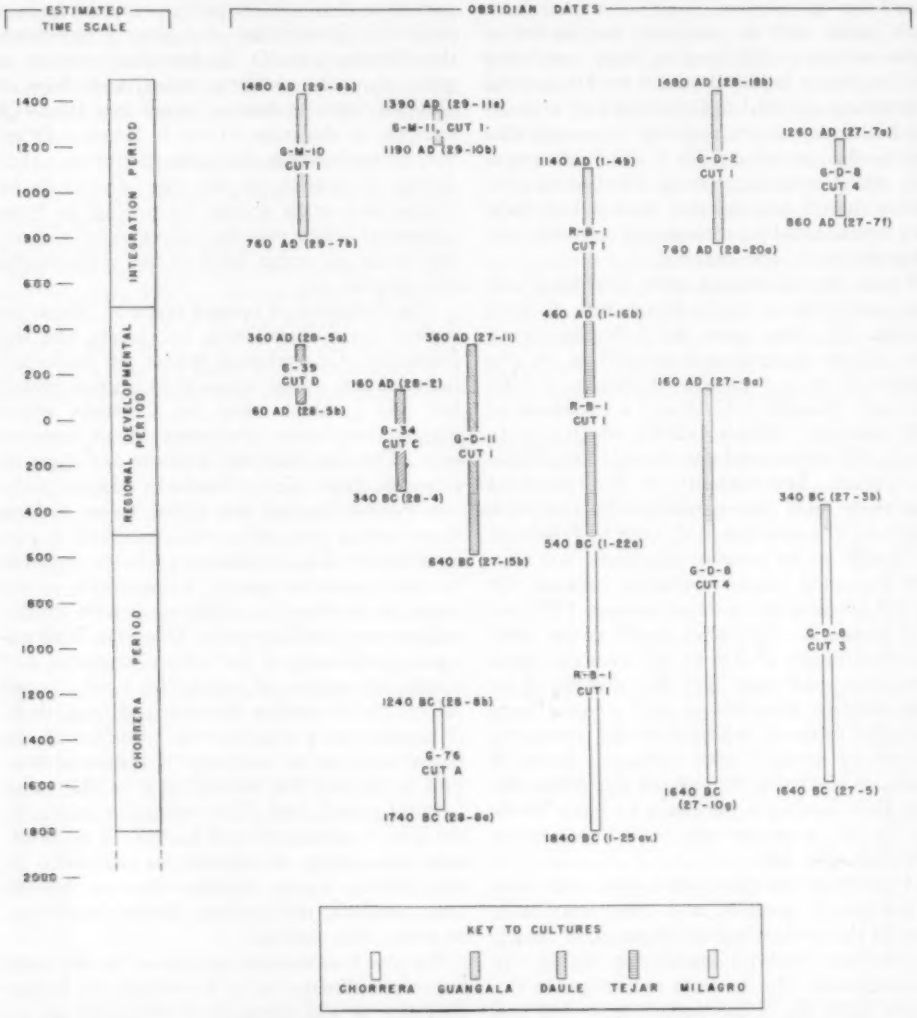

Fig. 19. Correlation of the seriated sequence and cultural subdivisions derived from pottery analysis on the coast of Ecuador with dates obtained from obsidian analysis. The cultural periods are shown at the left, with estimated durations based on radiocarbon dates and correlations with related portions of the Andean developmental sequence. The maximum and minimum dates derived from obsidian with the sample number from Table 1 are shown for 11 of the stratigraphic cuts. These obsidian dates correlate very closely with the estimated dates for the cultural periods. Also, the obsidian dates of sites of the same cultural complex are overlapping in age or contemporary.

17, 28–1 through 28–20, 29–1 through 29–15, 39–1 through 39–2). Discussion of the results will serve to emphasize two points already made (1) obsidian dates, like all other forms of "absolute" dates used in archaeology, can be relied upon only to the extent that they can be evaluated in terms of good relative sequences of cultures; and (2) several specimens per level should be examined so that re-used objects can be distinguished from those that are of contemporary manufacture.

G–34, Loma Prudente, is a site of the Early Guangala period with pottery showing features that are transitional between the Chorrera period and fully-developed Guangala culture. The obsidian specimens from Cut C (Samples 28–1 through 28–4) all have hydration layers of 4.4 to 5.0 microns except Samples 28–1a and 28–1b, which are 0.69 and 2.5 microns thick, respectively. Both of these are from the top level of the stratigraphic excavation (Level 0–20 cm., Fig. 20). Their converted dates of 43 years B.P. and 570 years B.P. are both far too recent to equate with the seriated position of the site and the objects must be interpreted as recent intrusions.* Three factors support this conclusion: (1) the position of the objects near the surface of the refuse deposit, (2) the fact that the site is physically within the limits of the modern village of Barcelona, and (3) the gap between the thickness of these hydration layers and those on the remaining samples from the site. The three samples from earlier levels give dates of 1800 to 2300 years B.P., which agree well with the chronological position of the site in the Guayas Province sequence (Fig. 19).

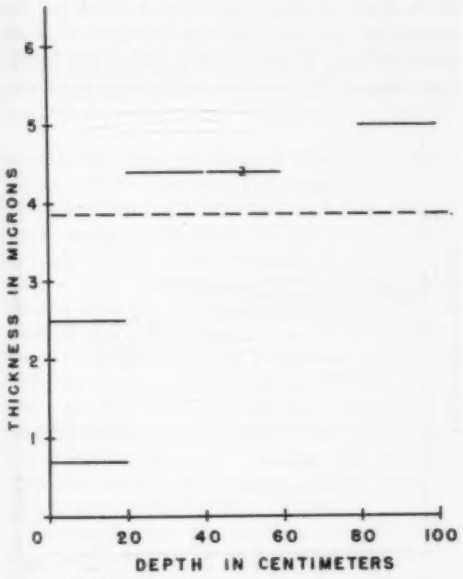

FIG. 20. Diagram of the thickness of the hydration layer on obsidian artifacts from Cut C at Site G–34, Barcelona, coastal Ecuador. The number 2 across a bar means that two samples have the same thickness. The dotted line divides the diagram into two sections: upper, those artifacts with hydration rims that reflect the age of the site (Early Guangala culture of the Regional Developmental period, Fig. 19); and lower, those artifacts with hydration layers reflecting recent or modern intrusion into the top level of the site (see text for detailed discussion).

G–D–2, Loma de las Lechuzas, is a Milagro site on the Daule River. Up to six samples per level were measured (Samples 28–18 through 28–20) and the results are plotted in Figure 21. Since this site represents the Integration period, which is the latest period on the Ecuadorian coast, only three of the specimens can be considered to have been chipped by the occupants of the site. These are Sample 28–18c with a hydration layer thickness of 2.2 microns, Sample 28–18b with a thickness of 2.3 microns, and Sample 28–20a with a thickness of 3.7 microns. The converted dates of 440, 480, and 1200 years B.P. are all within the estimated age of the Milagro culture (Fig. 19). All of the other artifacts measured have layers thicker than 4.0 microns and must be interpreted as objects obtained from earlier sites, of which there are several in the immediate vicinity, and re-used by the Milagro people. Extensive re-use is explainable by the fact that, while the natural source of the obsidian is in the foothills at a considerable distance, ready-to-use flake blades and scrapers are abundant in earlier sites, particularly those of the Chorrera period, presenting a convenient source of supply. The gap of 700 to 800 years between the age of the samples from Level 0–15

* If these objects were obtained from the refuse deposits of G–34 and were broken accidentally or from use, some portion of the original surface might remain. This could be determined by cutting additional thin sections from the same specimen, and in cases where the interpretation is uncertain this extra cutting and measurement should be done. Limitations of time have prevented making so detailed an examination of most of the specimens up to the present time, but two measurements on Sample 28–18c permitted the recognition of both an old and a recently broken edge. Future research will explore this situation further.

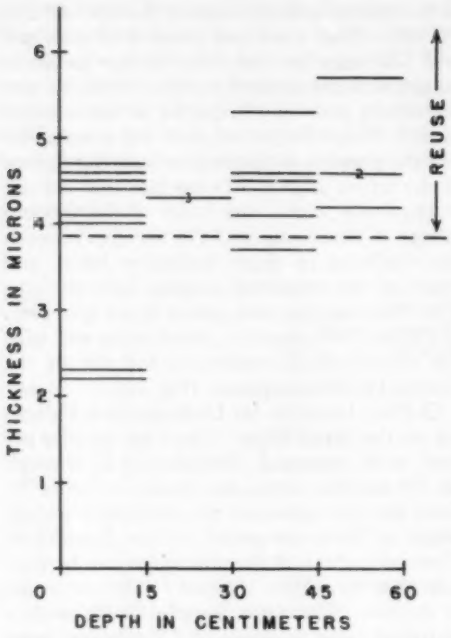

Fig. 21. Diagram showing the thicknesses of the hydration layers of obsidian artifacts from Cut 1, Site G–D–2, Las Lechuzas, coastal Ecuador. The numbers across several bars represent multiple samples of the same thickness. The dotted line divides the diagram into two sections: upper, those artifacts whose hydration layer is too thick for the chronological position of the Milagro culture, and which were obtained from earlier sites and reused by the Milagro people; and lower, those artifacts that actually reflect the age of the site (Milagro culture of the Integration period, Fig. 19).

cm. and that from Level 30–45 cm. suggests the possibility that the site may have been occupied early in the Milagro period, abandoned, and later reoccupied. If this interpretation is correct, it should be verifiable by the detailed analysis by levels of the pottery from the excavation, which has not yet been completed.

G–M–10, Altamirano, is a Milagro site farther inland near the present town of Milagro. Here, two to seven specimens (Samples 29–2 through 29–8) were measured from each level of the stratigraphic cut. The results again show that the people of this late period made extensive use of obsidian from older sites (Fig. 22). One fragment (Sample 29–4f) with a layer of only 1.6 microns can be eliminated because of its post-European date of 230 years B.P. Those with hydration layers of 2.3 to 3.6 microns thick give dates within the estimated duration of the Milagro culture, suggesting they are valid. The remaining 29 samples appear to represent re-use of artifacts from sites of the preceding cultural periods.

G–M–11, Cambio de la Balsa, another site of the Milagro culture near G–M–10, is represented by two to six obsidian specimens per level of the stratigraphic cut (Samples 29–9 through 29–12), as well as four from inside a broken burial urn found in one corner at the bottom of the excavation (Sample 29–13). The micron thicknesses of the hydration layers are plotted in Figure 23. The obsidian specimens that appear to have been chipped by the occupants of the site are Samples 29–10b, 29–10c, 29–11e, 29–13b, c, e with dates of 770, 600, 570, 820, 870, and 870 years B.P. respectively. All these dates are acceptable for the middle portion of the Integration period and their range of 300 years is not unreasonable for the duration of the site. If this conclusion is valid, all the remaining samples must be interpreted as reused artifacts. However, only three have hydration rims of 4.7 microns or more in thickness,

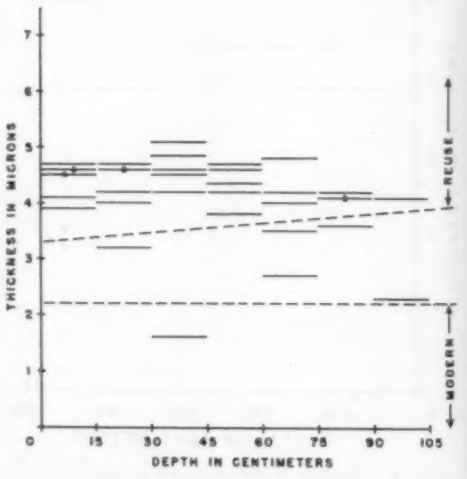

Fig. 22. Diagram showing the thicknesses of the hydration layers of obsidian artifacts from Cut 1, Site G–M–10, Altamirano, coastal Ecuador. The numbers across bars designate multiple samples with the same thickness. The upper dotted line separates artifacts whose thick hydration layers indicate that they were obtained from earlier sites and re-used by the Milagro people from artifacts that give an acceptable date (Milagro culture of the Integration period, Fig. 19). The lower dotted line separates out a thin sample that is of post-European origin.

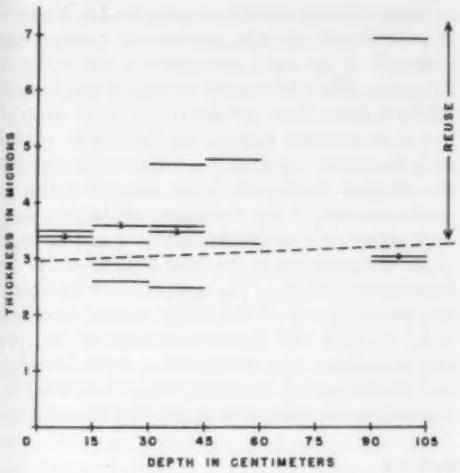

FIG. 23. Diagram showing the thicknesses of the hydration layers of obsidian artifacts from Cut 1, Site G–M–11, Cambio de la Balsa, coastal Ecuador. The numbers across several bars designate multiple samples with the same thickness. The dotted line divides the diagram into two sections: upper, those artifacts with thick hydration layers indicate that they were obtained from earlier sites; and lower, those artifacts that appear to date the site occupation (Milagro culture of the Integration period, Fig. 19).

identifying them as derived from sites of an earlier cultural period. The majority range in hydration layer thickness from 3.0 to 3.6 microns, representing dates of 820 to 1200 years B.P., that have been accepted as within the range of the Integration period (Fig. 19). This raises a different problem of interpretation. The specimens in this group occur in all levels of the stratigraphic cut and thus are associated with the three examples having thinner hydration rims that have been evaluated as giving an acceptable date for the site. The most logical explanation appears to be that this situation indicates re-use of obsidian objects from an earlier site of the Milagro culture.

This analysis of the obsidian dates from five stratigraphically excavated sites in the Guayas Province has been undertaken in considerable detail to demonstrate the necessity of establishing a detailed relative chronological sequence before the obsidian method of dating can be applied. Without such a standard of evaluation, an entirely erroneous result can be produced, such as the alignment shown in Figure 24. Here the results of the measurements of hydration layers of obsidian artifacts from two sites in the Guayas Basin have been plotted in adjacent columns, using the same scale for thickness of the hydration layers. Inspection would lead to the conclusion that since the hydration layers at G–D–1 (Samples 28–11 through 28–17) and G–D–11 (Samples 27–11 through 27–15) show approximately the same range of thickness, the sites are contemporaneous.

Unfortunately, examination of the relative chronological sequence derived from pottery type analysis makes this conclusion impossible. G–D–1 is a site of the Milagro culture and consequently belongs to the Integration period. Ceramically it is generally equivalent to the Milagro sites of G–D–2, G–M–10 and G–M–11, and it must be of similar age. The thinnest hydration layer, however, gives a date of 1700 years B.P. (Sample 28–17), and the majority are more than 2500 years old. In this case it is probable that the small size of the tested sample is to blame for failure to encounter a single acceptable date. It should be noted that for both G–D–2 and G–M–10, only one sample out of seven tested produced a contemporary date (Figs. 21, 22). Since only seven samples were measured from G–D–1, the probability of encountering one of contemporary date was not

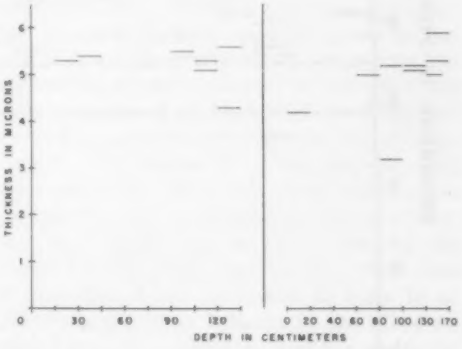

FIG. 24. Alignment of two coastal Ecuadorian sites according to the hydration layer thickness of the obsidian artifacts without regard to the cultural affiliations. G–D–1, Loma de los Naranjos, on the left is a site of the Milagro culture and belongs to the Integration period (Fig. 19). All the artifacts have thick hydration layers, representing the re-use of older material, a trait very common to the Milagro culture. The site on the right, G–D–11, Bijagual, belongs to the Regional Developmental period and in this case the thick hydration layer fits the relative chronological position of the culture as shown in Figure 19.

high. The dates for G–D–11, on the other hand, can be accepted as valid because the complex at this site belongs to the Regional Developmental period. The hydration layer thicknesses are perfect for this chronological position (Fig. 19).

Coastal Guatemala

The site of La Victoria, near Ocós on coastal Guatemala, has an accumulation of habitation refuse 5.70 to 6.00 m. deep, subdivided stratigraphically into four distinct complexes. Obsidian chips and flakes are abundant throughout the deposit. A large series of samples from Block E–3 of Michael Coe's 1958 excavations (Coe 1959a, 1959b, 1960) was measured with the results plotted in Figure 25.

Interpretation of the results at La Victoria is complicated by the absence of comparative material of the kind available on the coast of Ecuador. The problem of distinguishing re-used artifacts from those contemporary with each of the four cultural phases can be finally solved only by examining sites of a single period, where the thinnest hydration layers may be taken as representative of the antiquity of the site (except where all measured artifacts are re-used older specimens as in the case of G–D–1 on the Ecuadorian coast). The existence of radiocarbon dates for one of the complexes represented at La Victoria and the relationships of the pottery to culture complexes from coastal Ecuador and Mesoamerica, however, make it possible to suggest an interpretation of the obsidian results.

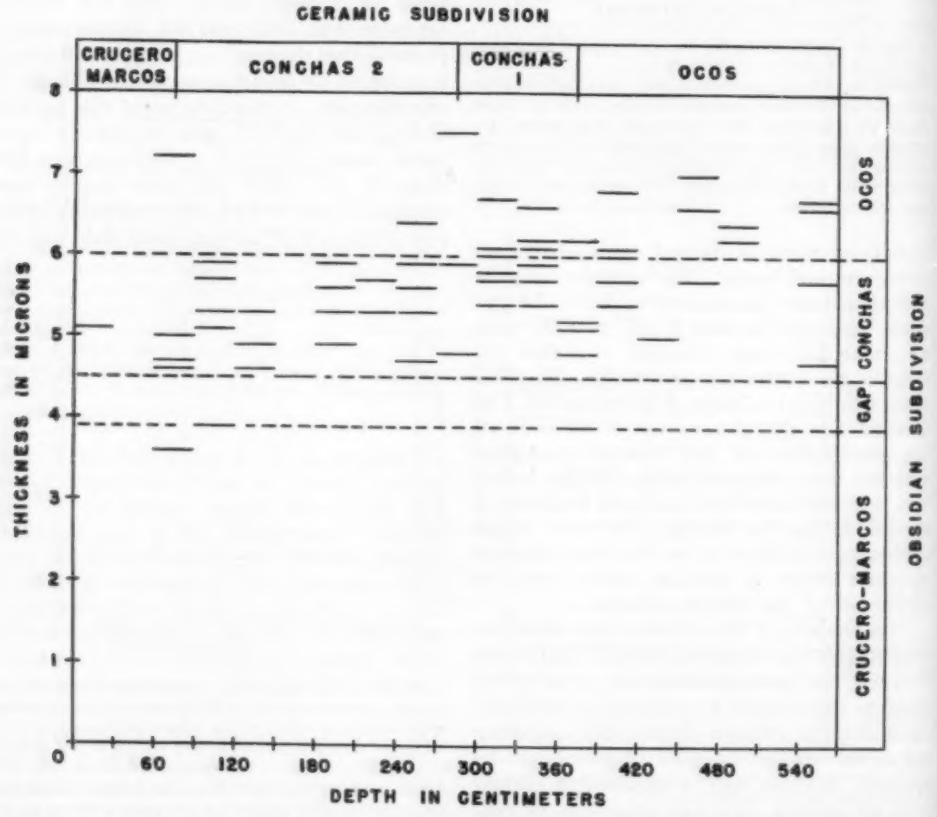

Fig. 25. The thickness of the hydration layers of the obsidian artifacts from various levels in strata Cut E–3, La Victoria Site, coastal Guatemala. The cultural divisions derived from pottery classification and the levels at which they subdivide are shown along the top. The cultural divisions obtained independently from the thickness of the hydration layers of obsidian are expressed on the vertical scale at the right.

The refuse deposit is subdivided by Coe on the basis of pottery classification into four cultural phases: Ocós (the earliest), Conchas (Subphase I and Subphase II), Crucero, and Marcos. Cross ties with La Venta phase in the Olmec area and the various Chiapa phases at Chiapa de Corzo in the state of Chiapas in southern Mexico, as well as the presence of plumbate pottery in the upper levels, permitted Coe to assign estimated dates to the phases at La Victoria. Ocós phase is estimated to begin about 1500 B.C. or earlier, and to last until the Conchas phase (Subphase I), which begins around 850 B.C. This guess date is based upon cross ties with radiocarbon dates from the sites of La Venta and Chiapa de Corzo. The Conchas phase (Subphase II) ends about 200 B.C. with the appearance of new traits that mark the Crucero phase. This latter phase is short lived, lasting until around A.D. 200; then there is a hiatus in the occupation of the site until the appearance of the Marcos phase that lasts from around A.D. 700 to 900.

Obsidian results coincide with the date of 850 B.C. for the beginning of Conchas phase. There are only two samples (45–14d, 45–17f) below Level 13 (which marks the cultural transition between Ocós and Conchas) that have hydration layers thinner than 5.4 microns. One of these (Sample 45–14d) is in Level 15 and gives a date that identifies it with the early part of the Conchas phase. The other (Sample 45–17f) gives a date of only 2000 years ago and undoubtedly represents accidental mixture from later refuse of the Crucero phase. The 13 remaining samples from the Ocós phase (Samples 45–13b–f; 45–15a, c, d; 45–16a–b; 45–17c–e) measure between 5.4 and 7.0 microns in thickness of the hydration layer, giving dates of 2600 to 4500 years B.P., or 640 to 2540 B.C. by Rate B. Although the maximum age is somewhat greater than expected, the range of the majority of the dates falls within the estimated range of the Ocós phase.

The obsidian dates for La Victoria can be evaluated not only in terms of related Mesoamerican archaeological complexes, but also in terms of the Chorrera and Tejar cultures of coastal Ecuador. Pottery of the Ocós phase is generally somewhat cruder and thicker than Chorrera pottery, but the number of distinctive features common to the two complexes leaves no doubt of their close affiliation. Conchas phase (Subphase I) shows similarly strong resemblances to the Tejar and Chorrera cultures. Various kinds of evidence have led to the conclusion that the Guatemalan occurrences are the earlier, and that the Ecuadorian cultures reflect Mesoamerican influence (Evans and Meggers 1957; Coe 1959a, 1959b, 1960). The obsidian dates support this interpretation. The range of Ocós phase dates based upon the hydration layer thicknesses of 6.0 to 7.5 microns (Fig. 25) is 3300–5100 years B.P., while the Chorrera phase has hydration layers ranging from 5.0 to 6.7 microns (Fig. 18) that convert into dates of 2300–4100 years B.P.

The Maya Region

Obsidian samples measured from Maya sites show such lack of consistency in thickness of the hydration layer that it is not possible to explain the discrepancies at present. Of the 30 samples measured, only four agree closely with the estimated dates (Samples 3–1a, 3–1b, 34–7, 35–1), when calculated according to Rate B. The remainder are older or younger than expected. Use of any other rate makes the disparities worse, and an effort to establish a separate rate for the Maya region based on calendar correlations and hydration layer thickness was not successful due to inconsistency of the hydration layers for samples from the same cultural complex. There is no evidence of burning, which would have speeded up the formation of the hydration layer. A check with the archaeologists who excavated or submitted the samples produced no information that suggested an archaeological explanation for the discrepancies. The association of the artifacts with the context in which they were found seems indisputable with the possible exception of Sample 35–2, which was recovered later by the native foreman from the dirt pile rather than at the time of the excavation of Stela 16 at Tikal. Re-use is not believed by the Maya archaeologists to be probable, and the small size of the sample tested per site prevents independent evaluation of this possibility at present. Investigation of the Maya obsidian problem should be continued on a more intensive scale with larger series of specimens from a variety of sites, and soil temperature studies should be made to understand better the temperature factor in the formation of hydration layers. When this has been done, some of the possible

sources of variation can either be eliminated or identified as significant, and a valid hydration rate can be established for the region.

Southwestern United States

Like the Maya region, the Southwest has not shown a very satisfactory correlation between estimated obsidian dates and estimated archaeological dates based on dendrochronology, radiocarbon, pottery sequences, and so forth. Originally, both Scales D and E were plotted, but even though there is close agreement for only two samples (24–4 and 24–6) when Rate D is used, the results from Rate E are even more divergent. For the Southwest, some of the disagreement may come from variation in the ground temperature between desert regions and plateaus or mountain valleys. Since differences in temperature influence the hydration rate, artifacts from Hohokam sites subjected to intense desert heat may have to be measured against a different rate than those from the White Mountains of Arizona or the cliff dwellings of Mesa Verde, Colorado. An effort to establish separate rates for these different climatic zones in the Southwest was made by plotting the thickness of the hydration layers against the estimated archaeological dates, but the lack of consistency in thickness of the hydration layers from sites with stratigraphic data was too great to permit the establishment of any reliable or meaningful rate at present.

Observation of practices among the present-day Navajo suggests that re-use may be an important factor in explaining dates that are too early for the context in which the obsidian artifact was found. Among the Navajo, as in the prehistoric Pueblo culture, stones of traditional colors, one of which is black, are an important component of the medicine man's kit. Jean Pinkley reported the following incident in a letter dated July 8, 1959. A small seed jar of Pueblo I or Pueblo II date was recently found in Mesa Verde National Park by a Navajo, who turned it over to Park officials. When received, this vessel contained one stone of each of the traditional colors except black. Questioned about its absence, the Navajo became uncommunicative, and it was clear that he had removed it for his own purposes. If this piece of obsidian is someday lost in a Navajo hogan, a future archaeologist who finds it and submits it for obsidian dating will receive a date considerably older than he expects. Unless he recognizes the possibility of re-use, he will be unable to explain the discrepancy. This situation has undoubtedly been repeated frequently in the past, and knowledge of its existence serves to emphasize the unreliability of dates derived from single samples.

As research continues and more samples are collected in the Southwest from sites with a variety of conditions of deposition, such as midden refuse, pit house deposits, and fill of rooms of the Pueblo periods, and soil temperature studies are made, it is hoped that some of the problems that now appear to confuse the use of obsidian for dating in the Southwest can be resolved.

Ohio

The obsidian results for the Hopewell culture are about as puzzling as some of the other aspects of the archaeological situation. A check of all the samples tested (Table 1, 2–1 through 2–7) shows that the hydration layers of the obsidian blades and flakes from the Hopewell ceremonial cache (Table 1, 2–3a through 2–3k) fall into two groups: one of 2.9 to 3.3 microns thickness, and another of 3.6 to 3.9 microns thickness. The 14 samples that fall within several tenths of a micron of a thickness of 3.0 were used as reference points for Scale E. Using 3.0 and 3.6 as the thickness around which most of the layers cluster, by Rate E there is a difference of 900 years between the ages of these two groups of artifacts. This suggests either that certain obsidian specimens were re-used or that some objects were kept for 900 years before burial. Archaeologists working on the Hopewell problem state that no earlier group in the area used obsidian, making re-use of older artifacts an unlikely explanation. At the same time, however, it seems doubtful that obsidian artifacts would have been manufactured hundreds of years before being placed in a ceremonial burial cache. Although all the specimens measured were carefully selected and those showing crackling from burning were eliminated, there is a possibility that some of the specimens with thicker rims were affected by their proximity to ceremonial fires. A larger number of samples from habitation refuse, in addition to specimens from ceremonial caches, are needed before the applicability of the obsidian dating technique to the Ohio region can be evaluated fully.

THE NEAR EAST

Samples tested from the Near East included specimens from Shanidar Cave, Jarmo, Amouq, Tepe Gawra, Ali Agna, Grai Resh, and others (Table 1, 42–1 through 42–7, 43–1, 43–2, 13–4 through 13–16). In the light of our present knowledge of problems inherent in the use of obsidian for dating, some of these samples are unsuitable and should not have been included in the preliminary analysis. This is particularly true of surface finds, where the possibility of reuse and definite cultural association cannot be evaluated, and intense exposure to the sun is likely to have altered the rate of formation of the hydration layer. Specimens from cultural sequences where there is disagreement among the archaeologists about the dates are also useless for evaluating the obsidian results. The majority of the disagreements between the obsidian dates and estimated dates from Near Eastern sites stem from such sources and consequently do not provide a reliable basis for assessing the applicability of the method. However, material was examined from well-defined stratigraphic sequences at Jarmo and Shanidar Cave, and these results deserve detailed comment.

Solecki submitted a larger series of obsidian specimens from Shanidar Cave than are shown in Table 1 (Sample 6–1 through 6–19), but a considerable number showed evidence of burning and consequently could not be used. The samples from different blocks in the excavation are not easy to put in sequence because of the sloping nature and variable thickness of the strata. Solecki has worked out these correlations on cultural grounds, dividing the deposit of the cave into four distinct layers. They are from top to bottom, or from most recent to oldest, as follows:

Cultural Layer A — Recent to Neolithic, with the top of the layer having modern Kurds materials and the bottom of the layer at its juncture with Culture Layer B dating as Proto-Neolithic or 10,600 ± 300 years B.P. (W–667) by radiocarbon.

Cultural Layer B — Mesolithic or very Late Upper Paleolithic (Zarzi), dated by radiocarbon from the aforementioned date at the top of the layer to 12,400 ± 400 years B.P. (W–179) at the bottom of the layer.

Cultural Layer C — Upper Paleolithic, Aurignacian-like (Baradostan) with a minimum radiocarbon date of 26,500 ± 1500 years B.P. (L–335H) near the top of the layer. A series of dates from the bottom of Layer C give an average of around 33,000 years B.P. from radiocarbon samples of 32,000 ± 3000 years B.P. (L–335I), 33,300 ± 1000 years B.P. (W–650), older than 34,000 (W–180), and 33,630 ± 500 years B.P. (GRO–1494). There are no dates transitional between the upper part of Layer C and the oldest date for Layer B.

Cultural Layer D — Middle Paleolithic, Mousterian (Hazer Merd), the oldest cultural layer. A radiocarbon sample from the top of the layer dates at about 50,000 ± 4000 to 3000 years B.P. (GRO–1455). The "absolute" date at the bottom of the layer is unknown. When the obsidian samples are arranged according to cultural layers, at the same time keeping levels of each cut in correct position so that no reverse stratigraphy is introduced, the obsidian dates based on Hydration Rate Scale D give the results shown in Table 2.

Sample 6–17 is younger than the postulated possible affiliation with Cultural Layer B, but since this specimen did not come from stratigraphically excavated levels, but rather "from the cleaning of the north wall," there is a possibility it might have come from Cultural Layer A. Its age is well within the range of this layer. Samples 6–13, 6–2, and 6–16 date within the range of Cultural Layer B according to the radiocarbon dates. Sample 6–9 was believed to be from "the top of Layer C," but the obsidian date of only 13,800 years B.P. aligns it more closely with the bottom of Layer B. Lacking other evidence to the contrary, its position seems best interpreted as transitional between the two cultural layers.

The real problem lies with Cultural Layer C. Although the stratigraphy and cultural remains provide no clear-cut evidence of abandonment of the cave for 10,000 to 13,000 years, nevertheless there are no radiocarbon dates between 12,400 years B.P. (W–179) at the bottom of Layer B, and 26,500 years B.P. (L–335H) from the upper part of Layer C. Most of the obsidian samples bridge this "gap" (Samples 6–9, 6–7a, 6–8a, 6–12, 6–11, 6–15, and 6–4). Sample 6–8 at the bottom of Layer C gives an obsidian date of 29,600 years B.P., which is close to the radiocarbon dates for this part of Cultural Layer C. Two alternative explanations for this contradictory situation are possible.

One is that climatic shift in the area during Late Würm (about 12,000 to 25,000 years ago) was great enough to lower soil temperatures to the point where the rate of hydration was significantly retarded. This would mean that the hydration rate of Scale D is not applicable to samples older than 12,000 years. This does not seem to be the case, however, for then all the obsidian samples from below Layer B should deviate grossly from the radiocarbon dates, whereas one sample gives a result within the expected range for Layer C. More precise in-

Table 2. Alignment of Obsidian Samples According to Cultural Layers at Shanidar Cave

Cultural Layers and Radiocarbon Dates	*Obsidian Sample*	*Provenience of Sample*	*Thickness of Hydration Layer in microns*	*Years B.P. by Rate D*
Cultural Layer A Recent to Neolithic Period	6–17	Found while cleaning North Wall; possibly Layer B	5.4	4,450
Proto-Neolithic 10,600 ± 300 years B.P. (W–667)	6–13	Cut B–9, B–10, B–11, B–12, 1.80 to 2.40 m.; Layer B intruded by Layer A	8.6	11,400
	6–2	Cut C–11, 3.00 to 3.25 m.; Layer B	8.9	12,000
Cultural Layer B Mesolithic or Very Late Upper Paleolithic Period (Zarzi)	6–16	Cut X–7, 1.25 to 1.50 m.; Layer B(?)	9.1	12,700
12,400 ± 400 years B.P. (W–179)	6–9	Cut B–9, B–10, 2.58 to 2.75 m.; believed to be the top of Layer C	9.5	13,800
26,500 ± 1500 years B.P. (L–335H)	6–15	Cut B–7, 1.75 to 2.25 m.; Layer B(?)	10.8	17,800
29,500 ± 1500 years B.P. (W–178)	6–4	Cut B–11, 3.25 to 3.50 m.; top of Layer C	11.3	19,600
	6–12	Cut C–9, 2.75 to 3.00 m.; bottom of Layer B or top of C	11.5	20,400
	6–11	Cut C–9, 4.00 to 4.25 m.; Layer C	10.3	16,300
Cultural Layer C Upper Paleolithic, Aurignacian-like Period (Baradostan)	6–7a	Cut A–7, 2.75 to 3.00 m.; Layer C	11.1	18,800
	6–8a	Cut A–7, 3.25 to 3.50 m.; Layer C	10.1	15,700
32,000 ± 3000 years B.P. (L–3351); 33,300 ± 1000 years B.P. (W–650); Older than 34,000 years B.P. (W–180); 33,600 ± 500 years B.P. (GRO–1494)	6–8	Cut A–7, 3.25 to 3.50 m.; bottom of Layer C	13.9	29,600
Cultural Layer D Middle Paleolithic, Mousterian Period (Hazer Merd)				

formation on temperatures in the Near East during the late Pleistocene are needed for resolution of this problem. The second possible explanation is that the obsidian dates are correct and that there is no hiatus in the occupancy of the cave. If so, this should be demonstrable by additional radiocarbon tests.

It is interesting to note that without radiocarbon dating, the obsidian dates would be acceptable in the light of the typological and stratigraphic evidence of the cave. The two samples that appear to reverse the stratigraphy (Samples 6–7a and 6–12) can be explained either as the result of re-use of older artifacts, an apparently common situation in archaeological refuse where younger cultures are living on older habitation deposits, or as the excavator expressed it, "the result of stratigraphical accident."

Jarmo presents another interesting situation that is not wholly reconcilable at this stage of the research on obsidian. Many of the Jarmo samples showed surface alteration and therefore were not usable, but enough specimens were available from various positions in the excavations to give a range from the Earliest Jarmo occupations on virgin soil through the Middle-Late Jarmo period. The results of the examination of this material (especially Samples 11–20 through 11–27) do not help to clarify the already confused Jarmo dating situation. Braidwood feels that the entire occupation of Jarmo could not have lasted more than circa 500 to 600 years, in spite of the span of several thousand years shown by radiocarbon dates. If this is true, the same problem develops with the obsidian dates, even if some of the very young pieces are ruled out as accidental mixture of more recently chipped materials. A comparison of obsidian Sample 11–21 with a date of 6200 years B.P., based on Scale D, from the Earliest Jarmo period, with 4800 years B.P. for obsidian Sample 11–26 from the Middle-Late Jarmo period, gives a duration of the site of 1400 years, or much longer than the cultural material suggests. Also, none of the "accepted"

radiocarbon dates for the Early Jarmo period of about 7000 B.C., or roughly 9000 years B.P., agree with either Braidwood's estimated occupancy of 4750 B.C., or 6700 years B.P., or with the oldest obsidian date of 6200 years B.P. (Sample 11–21).

The cause of these discrepancies is not known at present. It is interesting to note that a few of the obsidian dates for Jarmo agree better with Braidwood's early guess dates than they do with the great range of radiocarbon dates available for the culture; but even these obsidian dates are too inconsistent to draw any fundamental conclusions. In other words, at the present moment there is no way of knowing whether the archaeological, the radiocarbon, or the obsidian dates are "right." In the case of obsidian, there are several variables that must be thoroughly examined and ruled out. Detailed studies of the soil chemistry of the Jarmo area as a possible factor in the alteration of the surface of the obsidians, in turn affecting the hydration rate, must be explored. Since obsidian is used in many cultures in the Near East from Upper Paleolithic to Neolithic times, it is hoped that large series of excavated obsidian chips, flakes, and artifacts can be collected in the future and that, as some of the archaeological problems of Near Eastern sequences are ironed out by the archaeologists, some of the problems affecting the possible use of obsidian for a dating method in the Near East can be more adequately attacked.

CONCLUSIONS

Evaluation of the results so far obtained in the dating of archaeological horizons by the obsidian method indicates that the method has considerable promise if it is used with appropriate care and understanding of its present limitations. In some areas obsidian dates fall in line extremely well with the estimated dates of the archaeological sequences. In areas where disagreements between estimated site dates and the dates of obsidian artifacts are frequent, most of the discrepancies can be traced to two categories of possible variables, geological and archaeological. Geologically, the rate of hydration appropriate to some geographical regions is still uncertain, and problems of surface alteration from chemical properties of some soils are unsolved. Archaeological problems include the inability to evaluate the possibility of re-use or accidental association of earlier objects, or the intrusion of later ones into an earlier site, because the sample is limited to a single artifact. Examination of a larger number of specimens per level or site should make it possible to refine the rates of hydration and to discriminate between those specimens that produce a valid date for a particular level or site and those that do not.

The fact that obsidian lends itself to this type of analysis has frequently led archaeologists to inquire whether the method can be applied to other rock materials. The answer, unfortunately, is negative.

If continued research can resolve some of the geological problems of the hydration of obsidian and permit the establishment of reliable rates of hydration, archaeology will have a new dating method that will be at least as accurate as many of the methods now in use. This method will be rapid to apply and inexpensive. A successful solution to the problems still remaining will place archaeology once more in a position to benefit from basic research initiated in another field of science. If this point is reached, the names of geologists Irving Friedman and Robert L. Smith will join the ranks of outstanding benefactors of archaeology, such as A. E. Douglass, the astronomer who pioneered the study of dendrochronology, and Willard F. Libby, the chemist who devised the radiocarbon dating method.

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MOGOLLON SETTLEMENT PATTERNS IN PINE LAWN VALLEY, NEW MEXICO *

ELAINE BLUHM

ABSTRACT

Settlement patterns are described for each phase of the sedentary agricultural occupation of the area from Pine Lawn phase (200 B.C.–A.D. 500) through Tularosa phase (A.D. 1100–1250), when the area was abandoned. Through time domestic structures changed from rounded to rectangular, from semi-subterranean to surface, and decreased in size. Earlier villages tended to be on higher, more defensible locations while later ones were lower, closer to water and arable land. Villages were generally random in plan, and great kivas, the only ceremonial structures identified in the area, appear to have served more than one village. From the settlement pattern data it is possible to construct a population curve for the area which may be partially explained in terms of botanical and climatological as well as cultural factors. Pine Lawn Valley Mogollon may have had some multi-village social organization which in later times may have united the entire valley. In this respect the Mogollon may have been intermediate between the well-integrated, segmented Anasazi communities in the plateau and the more politically structured Hohokam communities in the desert.

BEFORE THE settlement patterns for any area may be plotted from archaeological evidence, three things must be done: (1) the area must be surveyed intensively to locate the majority of the sites; (2) some sites must be excavated; and (3) the chronological framework of the area must be outlined. That portion of the Mogollon area near Reserve in west-central New Mexico has been studied for many years by Martin, Rinaldo, Hough, Nesbitt, and others. Many sites have been excavated. The chronology is well established, based at first on a sequence of open sites (Martin and Rinaldo 1950a: 372–3), and later confirmed by cave stratigraphy (Martin and others 1952: 53–6). The settlement patterns for the Tularosa valley east of Reserve have recently been outlined by Wendorf (1956: 22–5). In this paper, I shall attempt a trial formulation of the settlement patterns of Pine Lawn valley, an area west of Reserve which has been intensively studied by Martin and Rinaldo of the Chicago Natural History Museum. The data on which this paper is based are on file at the Museum. The majority of sites in this study have not been excavated. The number of houses located in the pit house villages was estimated on the basis of the area of the site and the amount of land required for houses in excavated sites. In the case of pueblo rooms, the rooms themselves could be counted directly (Martin and Rinaldo 1950b: 567).

From an archaeological point of view, Pine Lawn valley is perhaps one of the best known sections of the Mogollon area. The valley is about ten miles long and three miles wide, with about 20 square miles of habitable land. It is divided by a low midway divide, and is drained in two directions. In the southern part of the valley Leggett Canyon flows southwestward, paralleling the San Francisco River, and then turns south until it joins the Saliz Canyon which flows into the San Francisco. Five smaller canyons flow down the western slopes into the Leggett. The northern part of the valley is drained through the SU and Starkweather canyons into the San Francisco River to the east. On the east and west rugged mountainous areas border the valley and converge to enclose it at the north and south. The part of the valley most suitable for sedentary villages lies in the center and to the west of Leggett Canyon; much of the remainder has rougher terrain. The area south of the midway divide has been most intensively surveyed; only a few sites have been located north of this.

The elevation of most of the valley ranges from 6200 to 6600 feet above sea level, although the divide on the east side is as high as 7200 feet in some places, and on the west it is even higher. Today much of the area is forested with juniper, piñon, live oak, and yellow pine. The average rainfall is about 14 inches per year; falling mostly in the summer with the remainder in the winter. The average growing season is 120 days. Present day economic activities include cattle grazing and some farming in the valley bottoms, and there is a sawmill for which timber is cut in the surrounding mountains. While there are only a few permanent inhabitants of the area today, there are indications of a rather sizable prehistoric population. The land available for agriculture,

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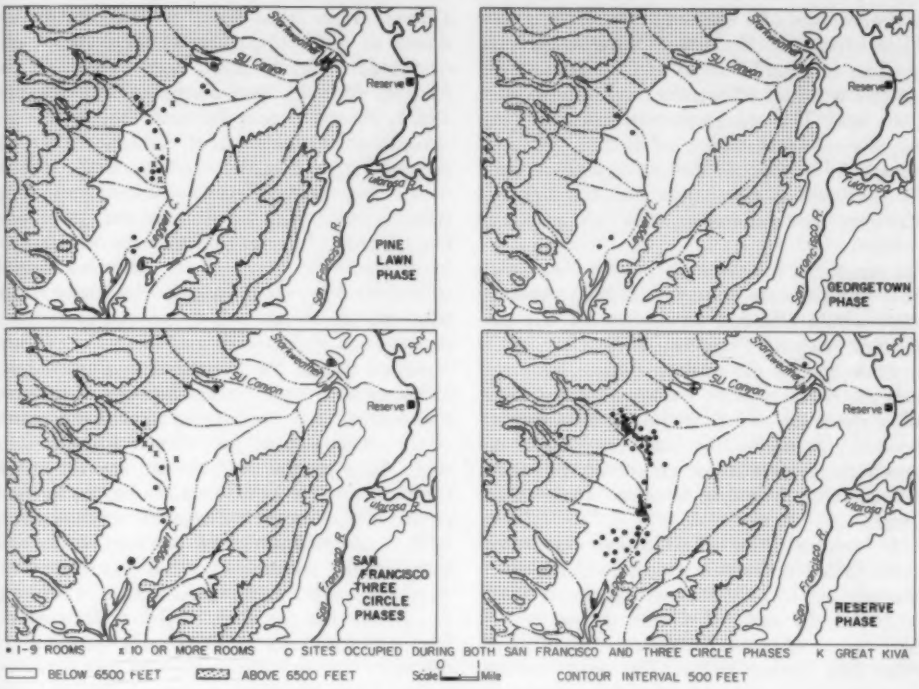

FIG. 1. Maps showing distribution of sites in the Pine Lawn valley.

the springs, and the streams which rise high in the mountains and which were running 75 years ago indicate the area was suitable for an aboriginal agricultural population.

THE ARCHAEOLOGICAL SEQUENCE

The earliest inhabitants of the area, so far as is known, were gatherers of the Chiricahua stage of the Cochise culture. Their camp sites were along the streams on the higher slopes of the valley (Martin, Rinaldo, and Antevs 1949: 34–64). At present there is not much information about these people and more work must be done before the settlement patterns can be determined. This preceramic period dates from perhaps 3000 to 200 B.C., and before the end of it the people in the area acquired agriculture (Martin and others 1952: 498).

The earliest agricultural and ceramic period found in Pine Lawn valley is the Pine Lawn phase which, it is estimated, lasted from 200 B.C. to A.D. 500. Twenty-one sites have been found which can be assigned to this phase (Fig. 1). Two of these, the SU site (Martin 1943, 1940; Martin and Rinaldo 1947) and Promontory site (Martin, Rinaldo, and Antevs 1949: 82) have been excavated, and two others have been tested. These sites contained round or oval pit houses with short lateral entrances or roof entrances. The houses appear to have been scattered at random without regard for spacing; but there was a definite tendency for the entrances to be oriented in an easterly direction. Pine Lawn phase sites had an estimated range of from one to 26 houses with an average of six. Six villages had more than ten houses, although all may not have been occupied at the same time.

In each of the two excavated villages there were kidney-shaped houses with short lateral entrances facing east which were larger than the other structures and are believed to have served some special ceremonial function. One at the SU site (A) had grooves around the periphery of the floor (Martin 1940: 14) which also serve to distinguish it from the other pit houses. Each of the two ceremonial structures at the SU site was associated with a group of

pit houses, one (A) located at the eastern edge of the village and the other (V) near the center. The ceremonial room at Promontory Village (B) was located toward the northern edge of the site. The village pattern seems to have been a random scattering of houses, generally oriented in an easterly direction, with ceremonial rooms which were larger than the domestic structures, but otherwise were quite similar to them.

In general, it may be said that the Pine Lawn phase villages were scattered on high mesas or ridges which afforded some view of the surrounding country. Promontory site, close to the southern end of the valley is quite high and there are three boulder walls across the south end of the mesa which may have been for fortification. Some of the smaller villages are located more toward the center of the valley and are close together or close to a larger village.

The second phase of Mogollon occupation in the valley is the Georgetown phase, from about A.D. 500 to 700. Six sites have been found which may be assigned to this phase, two of which were excavated (Martin and Rinaldo 1950a: 268; Nesbitt 1938). The pattern established during the Pine Lawn phase seems to have continued. The villages in the valley were composed of round or oval houses arranged in random plan, but again with a tendency for eastern orientation of the entrances. At Starkweather Village there were two round pit-structures which may have been ceremonial. They were larger than the other houses. Both had ramp entrances facing east; one had two floor grooves, the other, one. One structure (A) is located on the eastern edge of the village while the other (Q) is farther west.

Georgetown phase villages had an estimated range of from one to 14 houses with an average of six. In general, the villages were scattered without concern for defense, although both Starkweather at the northern end of the valley and Turkey Foot Ridge at the southern end were on high mesas or ridges. Both large and small villages appear scattered rather than clustered together.

The next two phases, San Francisco and Three Circle, cover an estimated time span from A.D. 700 to 1000. These phases have not been separated in this study because information from surface survey alone is not adequate to distinguish between them. Sixteen sites (Fig. 1) have been found which may be assigned to this period. Five of these have been excavated (Martin and Rinaldo 1947, 1950a; Martin, Rinaldo, and Antevs 1949; Nesbitt 1938). At this time a change in house plan occurred and the majority of domestic structures were rectangular rather than rounded. Houses in the excavated villages continued to have a random pattern of distribution and, as before, the majority of the entrances were oriented toward the east. At each of three excavated sites there was one pit house which was larger than the others and which may be considered ceremonial. Pit house K at Turkey Foot Ridge, occupied during the San Francisco and Three Circle phases, was rectangular with a possible roof entrance. It was located toward the center of the main part of the village. On the four sides of the central fire pit were grooves in the floor which may have been resonators for foot drums. Pit house B at Starkweather was round with a stepped entrance on the north, and was partially masonry lined. It was located toward the eastern edge of the village. Pit house D on the western edge of Twin Bridges site was rectangular with a short ramp entrance on the east.

The Three Circle phase room at the SU site, which Martin and Rinaldo (1947: 310) believe to have been a rectangular kiva, differs from the others in that it is smaller and has a ventilator rather than an entrance. This structure appears to have been something of a departure from the Mogollon pattern in the area prior to this time although a house with a ventilator built into the earlier entrance was found at Turkey Foot Ridge site (Martin and Rinaldo 1950a: 250). Its use as a ceremonial room remains uncertain.

San Francisco and Three Circle phase villages had an estimated range of from one to 26 houses with an average of nine; eight had ten or more houses. These villages were, in general, scattered, although there was a tendency toward a concentration in the central part of the valley along Dry Leggett Canyon. Although the two villages on either end of the valley were on high mesas or ridges, the remainder of sites were high or low with more concern for arable land and access to water than defense.

The Reserve phase, A.D. 1000 to 1100, is apparently the last period of extensive occupation in the valley. This phase was marked by another distinct change in architecture, for at

this time masonry pueblos were introduced. Sixty sites have been located (Fig. 1) which were occupied in the valley during this phase, six of which have been completely or partially excavated (Martin 1943: 256; Martin, Rinaldo, and Antevs 1949: 126; Martin and Rinaldo 1950b; Bluhm 1957). These pueblos were small and compact and there was a reduction in the area occupied by a single site. The number of rooms per pueblo varied from one to 12 with an average of five; only three sites had more than ten rooms. The average area of the individual pueblo rooms was smaller than the average area of the pit houses and there was considerable variation in the size of rooms in any given pueblo, with the smallest pueblo rooms being smaller than any pit houses.

Several of the small pueblos had very few sherds around them, and one of those which was excavated (Martin 1943: 256) lacked fire pits. Perhaps these structures served as storage houses in the more concentrated areas of habitation sites. They are so close to the other pueblos that it seems unlikely that they were outlying farm houses.

The small Reserve phase sites first excavated (Martin and Rinaldo 1950b) included no ceremonial rooms, but the Sawmill site (Bluhm 1957), a larger pueblo of about eight rooms located on a mesa along Dry Leggett Canyon near the center of the valley, has a large rectangular semi-subterranean ceremonial room with a long wide ramp entrance. At first this room was a jacal structure but later had masonry walls. Floor features included a fire pit and two parallel floor grooves or resonator troughs near the center. This is the only structure of its type in the valley, although others have been excavated outside of the valley (Rowe 1947; Martin, Rinaldo, and Barter 1957). It is possible that during the Reserve phase the valley was a sufficiently integrated unit that one great kiva or ceremonial structure served the entire area. The Reserve phase community may have consisted, therefore, of small pueblos of four to eight rooms clustered, for the most part, in the more open areas along the water courses, a few scattered storerooms and one large ceremonial room. No effort seems to have been made to locate the sites with regard to defense, but rather they were along the valleys and the edges of the mesas bordering the canyons, and a few were farther up the valley slopes. There was a concentration of sites along Dry Leggett Canyon, near the Sawmill site, in the area where the small concentration of San Francisco and Three Circle phase sites occurred.

The last phase of the Mogollon occupation in the Reserve area is the Tularosa phase dating from perhaps 1100 to 1250 or 1300. The only Tularosa phase site in Pine Lawn valley is Starkweather Pueblo, which is at the extreme northeastern end of the valley, on a high mesa above Starkweather Canyon, not far from where it drains into the San Francisco River to the east. However, farther east, on the San Francisco–Tularosa drainage there are many Tularosa phase sites which are, on the average, larger than the Reserve phase sites in Pine Lawn valley (Schroeder 1954: 66–104; Peckham, Wendorf and Ferdon 1956: 18–65; Martin and others 1956; Martin, Rinaldo, and Barter 1957). There are also several large rectangular ceremonial rooms, scattered several miles apart, each associated with a large pueblo or group of pueblos. Because of the number of sites there and the increase in size of sites, it seems plausible that at this time there was a tendency for greater concentration of population and the Pine Lawn valley people may have moved to join their neighbors a few miles to the east. The reasons for such a concentration are not known. Perhaps as Danson (1957: 111–8) suggests, enemy people were responsible for this movement; or, perhaps the drought about 1050 (Schulman 1938) forced the people to move into the Tularosa and San Francisco valleys where there was a larger and more dependable water supply.

Settlement and Population

While more field work is necessary to obtain the settlement patterns for the Mogollon area as a whole, certain tentative hypotheses regarding settlement and population in Pine Lawn valley can be stated at this time.

Location. The earliest villages in the valley, as in the Tularosa valley to the east (Wendorf 1956: 22–3) and other parts of central New Mexico and Arizona (Danson 1957: 103), were often located on defensible mesas or ridges, but later the sites occurred at lower elevations along canyons and on mesas close to water and arable land. This may reflect an early need for defense which disappeared as time passed; or, perhaps the earlier people who depended on hunting as well as agriculture built their villages in areas which were more suited to this mixed subsistence pattern, while later groups,

with increased dependence on agriculture, moved closer to the larger, more dependable sources of water.

Village Composition. From early to late the size of dwelling rooms in Pine Lawn valley tended to decrease. As the number of sites increased, the average number of rooms or houses per village at first increased, and then, in the Reserve phase, decreased (Table 1). The larger pit house villages have one or two ceremonial rooms which were larger than the dwellings. These ceremonial rooms may have served the smaller villages around them as well as the immediate village, so that there may have been multi-village communities in the valley at an early time. During the Reserve phase there is some evidence to suggest that the valley as a whole could be considered one community with one ceremonial structure.

There is no apparent planned arrangement of either the earlier pit house villages or the later pueblos, except that there was a general tendency to orient pit houses in an easterly direction when the topography permitted it. The change in the shape of the ceremonial pit-structures from round to rectangular corresponded to the change in shape of domestic structures, although it lagged in time; semi-subterranean ceremonial rooms were retained after surface living rooms were adopted. Floor grooves or footdrum resonators, fire pits, and eastern entrances are common, although not universal features of the ceremonial rooms throughout the occupation of the area.

Social Organization. Although it is impossible to definitely determine the social organization of the inhabitants of any pit house or pueblo, there has been some speculation about this. Martin and Rinaldo (1950b: 556–69) found that in addition to the decrease in size of pit houses and rooms from early to late there was a decrease in the number of metates and other stone tools per room. Therefore, they suggest that during the Pine Lawn phase individual pit houses were occupied by extended families; that from the Georgetown through the Three Circle phase nuclear families occupied pit houses, while related families may have lived in nearby houses in the villages; and that during the Reserve phase each individual pueblo was occupied by the members of a single extended family. Because he found no decrease in size of houses in the Tularosa valley, Wendorf (1956: 23) suggested that all houses or rooms in that area were occupied by nuclear families. Actually within any given area both may have been the case and closer consideration of the ratio of tools per house may be the most reliable key to the composition of the individual households. In this paper I have followed Colton (1936) and assumed that two pueblo rooms were the equivalent dwelling space of a single pit house. On this basis, there is little decrease, if any, in the number of tools per dwelling unit after the Georgetown phase. For this reason, it may be suggested that the dwelling units in the pit house and pueblo villages from the Georgetown phase on may have been occupied by nuclear families and that the individual multi-roomed pueblos may have been inhabited by one or more nuclear families depending on size.

Table 1. Size of Sites by Phase.

Phases	Number of Sites	Number of Centuries	Total Number of Rooms	Rooms or Dwelling Units per Century*	Average Number of Rooms per Site	Number of Domestic Rooms Excavated	Average Domestic Room Size in Square Meters	Number of Ceremonial Rooms Excavated	Average Ceremonial Room Size in Square Meters
Tularosa — A.D. 1100–1250	1	1	12	6	12	12	14.8	—	—
Reserve — A.D. 1000–1100	60	1	273	136	5	23	12.4	1	91.4
San Francisco–Three Circle — A.D. 700–1000	16	3	151	50	9	41	18.4	4	59.7
Georgetown — A.D. 500–700	6	2	34	17	6	3	14.5	2	22.1
Pine Lawn — 200 B.C.–A.D. 500	21	7	122	17	6	28	30.7	3	86.2

* Two pueblo rooms equal one pit house dwelling unit.

In Anasazi villages in the north small kivas are common, if not by Pueblo I, certainly by Pueblo II. In scattered sites in that area great kivas are also present. It has been suggested (Steward 1937; Hawley 1950) that the small kivas are associated with lineages, clans, or societies, and it is possible that the great kivas may have served larger groups (Hawley 1950) or as ceremonial centers for several pueblos in an area.

Mogollon sites in Pine Lawn valley lack the small kivas which are so common in the north, although it is possible that some dwellings also served as places for ceremonies. On the other hand, the presence of the few great kivas and the absence of small kivas suggests that there may have been a difference in emphasis, if not in organization, between this Mogollon community and the Anasazi villages. There is no reason to deny the presence of clans, lineages, or societies in Pine Lawn valley, but perhaps there was less emphasis on the segmentation of the community which is suggested by the small kivas in the north, and more emphasis on village and community cohesion. There may have been some strong central authority in Pine Lawn Valley, at least during the Reserve phase, which served to integrate the scattered villages in a single community. This authority may have been sacred or secular, or the integration may have been along kin lines. The archaeological evidence of the great kiva suggests that the authority was most likely of a ceremonial nature. It is interesting to note here that Eggan (1950: 176, 221) found more emphasis on village integration occurring among the Zuni who may be the descendants of the Mogollon (Martin, Rinaldo, and Barter 1957: 134) than among the Hopi who are frequently regarded as having a typical early Pueblo type of social organization.

Population. An attempt to estimate population from archaeological data is never very satisfactory, but a study of the number of houses or dwelling units may give some idea of the trend in population throughout the occupation of the valley. To do this, the estimated number of dwelling units assigned to a given phase or period in the valley was divided by the number of centuries in that phase or period in order to equate the time periods. This is not meant to indicate that the houses were occupied for 100 years or that all were occupied at the same time; but is a way of estimating population trend in lieu of dates for each structure in the area. Throughout this study it was assumed that two pueblo rooms were the equivalent living space of one pit house.

The number of dwelling units per century in the Pine Lawn phase is slightly more than 17, and in the Georgetown phase it is 17. This slight decrease may not be very important, except that it suggests that there was no increase. This is of particular interest when considered in the light of a discovery in Tularosa Cave, located north and east of the valley. There studies of plant remains revealed that in the Georgetown phase levels there was a decrease in the amount of cultivated foods and an increase in the amount of wild foods utilized by the people. Cutler (Martin and others 1952: 469) suggested that the shift in plant utilization might indicate a more nomadic way of life or might reflect a change in climate which temporarily reduced the yield of the cultivated crops and made it necessary to rely more on others. Schulman (1938) describes a period of sharp drop in rainfall from A.D. 495 to 515; a period of decline when the rainfall was well below normal from 590 to 650; and a decrease and the beginning of a major drought at 690 to 700. An examination of the regional mean graph of the tree ring growth in the period from A.D. 500 until 700 (Schulman 1954, Fig. 4) suggests several short periods of low rainfall during this period throughout the Southwest. The lack of increase in population during this period and the shift in food plants in Tularosa Cave may indeed be the result of a less favorable climate during this period.

During the San Francisco and Three Circle phases, there is a sharp increase to 50 houses per century. At this time there was an increase in the amount of cultivated plants utilized by the inhabitants of Tularosa Cave and a new type of corn was introduced into the area (Martin and others 1952: 469, 484, 496). There are also new traits in the material culture, suggesting increased communication and trade with other areas in the Southwest as well as an increase in population in the valley at this time.

During the Reserve phase, the population continued to increase; the number of dwelling units per century is 136. Part of the increase in the number of dwelling rooms and sites may be due to the possible migration into the area of people from the north, who may have introduced Reserve Black-on-white pottery with

its new designs, masonry pueblos, and other Anasazi traits. At present the evidence for such a migration is largely conjectural, based in part on ceramics and architecture. It has been suggested (Bluhm 1957: 78) that at least one site, which had a larger percentage of Mimbres Black-on-white sherds may have been occupied by descendants of earlier indigenous Mogollon Indians while other Reserve phase pueblos with larger percentages of Reserve Black-on-white pottery were occupied by the newcomers. At one of the latter sites, there was a quantity of Lino Gray sherds which might have been brought in from the north as utilitarian vessels (Martin and Rinaldo 1950b: 544). The suggestion by Peckham (1957: 38) that the Mimbres decorated sherds represented possible mixture of Three Circle phase occupation is an alternative hypothesis which was considered but the absence of Three Circle phase decorated types and the slight variations in percentages of plain and textured types in the various stratigraphic levels (Bluhm 1957: 32–5) in the site argue against it.

Pine Lawn valley seems to have been abandoned before the Tularosa phase except for the Starkweather Ruin, which is on a high mesa at the northeastern end of the valley; thus the population of the valley falls abruptly.

Abandonment. Why Pine Lawn valley was abandoned is not known. Its isolation may be part of the reason, for the valley is away from the main stream of the San Francisco–Tularosa drainage. This movement out of the valley may also have been one step in the trend toward increasing consolidation of pueblo communities which was going on elsewhere in the Southwest at this time, and which Morris (1939: 39–41) believes resulted from choice rather than fear. However, until more data are available, archaeologists should consider the alternative hypotheses that fear of enemy people may have forced the abandonment of smaller, more isolated areas or that perhaps the drought from 1050 to 1100 mentioned by Schulman (1938) was severe enough to reduce the water supply along the smaller streams and cause the inhabitants to move to the larger valleys with more reliable streams. Although the reasons why the Mogollon left Pine Lawn valley are not known, it seems likely that they joined others along the San Francisco River to the north and east.

Conclusion

Pine Lawn valley is only a small part of the Mogollon area which Wendorf (1956: 22) has characterized as consisting of isolated valleys separated by high mountains. We will not fully understand the settlement patterns for this region until we have more intensive studies like those of Martin and Rinaldo and Wendorf in the Reserve area and Haury at Forestdale and Point of Pines in Arizona. Because the area is divided by mountain barriers it may be culturally less homogeneous than the plateau to the north or the desert to the south. To understand it, it is important that not only widely separated areas be studied, but also valleys which are close to one another. In this way both inter and intra valley settlement patterns may be determined.

The Mogollon area is an interesting one, lying between the plateau where the Anasazi villages, at least after A.D. 1000, have an almost stereotyped pattern of pueblo rooms, small kivas and refuse mounds (Reed 1956) and the desert where the Hohokam villages lack kivas, occasionally have ball courts, and where there is a vast network of irrigation canals (Haury 1956). As Haury points out, these differences in village plan may reflect differences in social organization — apparently well-integrated and segmented Anasazi communities in the north and more politically structured Hohokam villages in the south.

In this paper I have presented a trial formulation of settlement patterns for one part of the Mogollon area, and have suggested the type of social organization these patterns may reflect. The lack of small kivas suggests less emphasis on the importance of the segmentation of the community than is found in the north. However the presence of scattered great kivas, which may have served communities consisting of several villages, suggests the possibility of some over-all intra-valley or community integrating force. Although these great kivas may have been built by cooperative efforts of individuals from several villages in the area, and may, therefore, indicate some level of community cooperation, there is nothing in the area to suggest the degree of over-all organized community activity which must have been necessary to construct and maintain the large network of irrigation canals found in the south. Mogollon social organiza-

tion, at least in Pine Lawn valley and eastern Arizona may have been intermediate between the cultures to the north and south.

The explanation for this is, at this time, largely a matter of conjecture. The reasons, in part, may lie in the proximity of the three areas to Mesoamerica, the source of many stimuli. The Mogollon are farther from that area than the Hohokam, but closer than the Anasazi, and may, therefore, have a social organization which reflects this position. Or perhaps Mogollon social organization was a product of elements borrowed from both north and south, or the continuation or intensification of an earlier pattern which may underlie all three.

Whatever the origins of the forms of organization reflected in the settlement patterns, the fundamental reasons for their adoption and development must lie within the cultures themselves. It appears that in all three areas prior to A.D. 700 there was a similar village pattern (Haury 1956: 5). The later patterns diverged from this in response to the problems peculiar to each region.

What appears to have been a strong political organization of the Hohokam developed in part, at least, because it was necessary to build and maintain an irrigation system in order to produce enough food to support an increasing population in the desert. Mogollon social organization may in part be the result of the relative isolation of rather small groups living in small valleys where the emphasis may not have been so much on the relationship of outsiders to those in the valleys, as the internal organization of the groups themselves. Anasazi social organization may have been a response to a different internal development, perhaps as a result of the need to integrate the rapidly increasing population concentration in communities in the area — communities which may have grown not only as a result of natural increase but also as a result of movements of peripheral people into the villages.

Obviously speculation of this type must stand the rigorous tests of an extensive and intensive future research. Haury (1956) has pointed out the need for intensive areal surveys, studies of ecology, and the functional analyses of the data obtained. More specific research problems are the standard typology of sites, a standard frame of reference for population estimates, a means of dating structures within a village as well as villages within areas, and more critical analyses of material culture in an effort to interpret, if possible, functional differences in rooms in villages, residence patterns of related peoples, and patterns of commercial or ceremonial interaction between villages as well as areas. The Southwest is a particularly good laboratory for such research as preservation is good, sites abound and are relatively easily detected, and many archaeologists have been working there for a long time.

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A REVISION OF THE ARCHAEOLOGICAL SEQUENCE IN SINALOA, MEXICO *

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ABSTRACT

An archaeological sequence for the Sinaloa coastal strip of western Mexico had previously been developed by Sauer and Brand, Isabel Kelly, and Gordon Ekholm. Investigations carried out by Southern Illinois University and associates from 1952 to 1958 in Durango, across the Sierra Madre Occidental to the east of Sinaloa, have established an independent archaeological sequence. The presence of trade pottery and other artifacts from Sinaloa in the Durango sites makes possible an independent check of the Sinaloa sequence. This cross correlation essentially confirms the basic Sinaloa sequence of (early to late) Chametla, Aztatlán, and Culiacán periods, but indicates that there is some overlap between these major horizons and that the Aztatlán period is actually divisible into three more or less sequent phases: an early Lolandis phase, an intermediate Acaponeta phase, and a terminal Guasave phase. Re-examination of the Sinaloa sequence confirms and expands these conclusions, resulting in this revision of the archaeological sequence for Sinaloa. For consistency, a revised terminology for the various phases is also presented.

THE COASTAL STRIP of northwestern Mexico lying along the Pacific Ocean and the Gulf of California in the state of Sinaloa and adjacent sections of Nayarit and Sonora, has long been of interest to archaeologists (Fig. 1). This narrow strip of land, bounded on the east by the *barranca* country of the Sierra Madre Occidental, and on the west by the ocean and the gulf, was a potential corridor of cultural and ethnic movement between Mesoamerica and the American Southwest. Furthermore, at the time of the Spanish conquest, a tongue of Mesoamerican culture actually occupied this area, extending northward to the northern boundary of Sinaloa. Consequently, the archaeology of this region is of special importance to students of Mesoamerica and the Southwest.

Archaeological work in this area began with a reconnaissance carried out by Carl Sauer and Donald Brand in 1930 (Sauer and Brand 1932). Isabel Kelly excavated at Chametla, in southern Sinaloa, in 1935 (Kelly 1938) and at Culiacán to the north in 1935 and 1939 (Kelly 1945). Gordon Ekholm excavated a site at Guasave in extreme northern Sinaloa in 1937, and carried out a reconnaissance of this area and adjacent sections of Sonora (Ekholm 1939, 1942). Kelly and associates completed an archaeological survey of southern coastal Sinaloa, Nayarit, Jalisco, and Colima in 1939 (Kelly 1939), and E. W. Gifford made a reconnaissance of the region around Ixtlán del Río in Nayarit in 1946 (Gifford 1950).

In the summers of 1952, 1954, 1956, and 1958, the Southern Illinois University, utilizing its own funds and various foundation grants from the American Philosophical Society (1952), the Wenner-Gren Foundation for Anthropological Research (1952, 1954, 1956), the University of Chicago (1956), and the SKF–American Anthropological Association program (1956), conducted archaeological survey and excavation in the adjacent Mexican state of Durango (Fig. 1). Our associates included especially Román Piña Chán (1954, 1958) of the Dirección de Monumentos Prehispánicos, Instituto Nacional de Antropología e Historia, Mexico; Agustín Delgado (1956), then with the Instituto Nacional; and other members of the Museum staff and students at the Southern Illinois University.

An unexpected bonus from the Durango investigations was the discovery of a great number of trade sherds and other artifacts imported from the Sinaloa coastal region. These trade specimens, properly placed in the Durango sequence, provide additional evidence for evaluating the independently established Sinaloa sequence. In general, the position of the Sinaloa intrusives in the Durango sequence verifies the established coastal sequence. However, certain data were recovered which suggest the necessity of a detailed revision of the Sinaloa sequence, a conclusion which has been further substantiated by a review of the evidence for the coastal sequence. In this paper we present the Durango data and those derived from our restudy of the coastal evidence, and propose a revised Sinaloa sequence based on these new data. Because of certain inconsistencies and contradictions in the names applied to the Sinaloa archaeological units, the propsed revision also includes a new and consistent terminology. It is our hope that before this revision receives general acceptance

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Fig. 1. Map of western Mexico.

and usage it will be carefully and critically examined and checked by Mesoamerican archaeologists, particularly by those responsible for the establishment of the original Sinaloa sequence.

The Original Sinaloa Sequence

The original Sauer and Brand reconnaissance established the geographic boundaries and the general nature of the Sinaloa archaeological complexes. In addition, these workers recognized several of the outstanding ceramic styles and in effect blocked in the concepts of a general "Aztatlán" coastal culture and the more restricted Chametla, Mazatlán, Culiacán, and Tacuichamona cultural styles or areas (Sauer and Brand 1932).

Kelly's excavations near Chametla established a sequence of Early Chametla, Middle Chametla, Aztatlán Red-rim decorated (identified in Kelly 1945, Table 13, as Late Chametla II), and El Taste–Mazatlán (Late Chametla I in Kelly 1945, Table 13) ceramic complexes (Kelly 1938: 39, Table 3). In her excavations near Culiacán, Kelly recognized the Aztatlán complex (Early Culiacán II) as her earliest unit there, followed by Early Culiacán I, Middle Culiacán, and Late Culiacán (Kelly 1945: 120, Table 13).

Ekholm identified the artifacts and burials found in the mound which he excavated at Guasave as belonging to the Aztatlán complex of other Sinaloa workers, although he was quite conscious of the considerably more elaborate nature of the Guasave materials. He also identified, both at the Guasave site and in the drainage of the Río Mayo, an archaeological unit which he named the Huatabampo complex, or culture (Ekholm 1942).

The currently accepted Sinaloa archaeological sequence (Fig. 2) derives from the work of these investigators. In general the sequence recognizes three horizons of culture: an earlier Chametla horizon (with two phases or periods) known only from the south; a pan-Sinaloa (and Nayarit-Jalisco) coastal culture, the Aztatlán complex, regarded as an essentially contemporaneous development throughout; and a subsequent Culiacán horizon, lasting until the Spanish conquest and so far known only from the Culiacán region, where it was presumably a local manifestation of the widespread Sinaloa culture of the conquest period.

Certain other local manifestations are attached loosely to this scheme. The El Taste–Mazatlán complex is regarded as essentially the equivalent of Early Culiacán I in time, while the Huatabampo complex is thought to be an early culture in northern Sinaloa and southern Sonora, preceding but overlapping the Aztatlán complex at Guasave. The Tacuichamona culture is somewhat tentatively accepted as a rather late local development in the central foothill region, probably equating with the Culiacán horizon. Essential to the entire correlation is the recognition of an Aztatlán complex at Chametla, Culiacán, and Guasave.

In terms of general Mesoamerican sequences and chronology, the Chametla horizon has, on very slim evidence, generally been regarded as essentially Classic in age; the Aztatlán horizon as Early Postclassic (Toltec), and the Culiacán

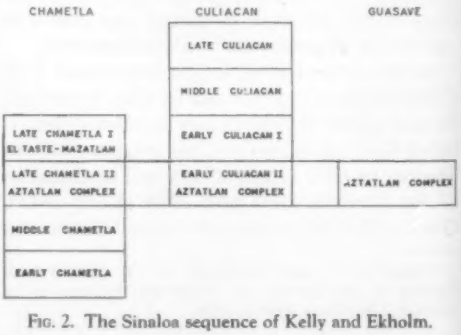


Fig. 2. The Sinaloa sequence of Kelly and Ekholm.

horizon as Late Postclassic (Historic; Chichimeca-Azteca) in affiliation (Lister 1955: 52, Chart 2; Marquina 1951: 924, "Quadro Comparativo . . ."). Ekholm, on the basis of the presence of certain Mixteca-Puebla traits in the complex at Guasave, originally placed the Aztatlán complex quite late, perhaps as late as the middle 14th century (Ekholm 1942: 130). However, he has revised this view considerably, and now places the Aztatlán complex shortly after A.D. 900 and early in the Postclassic (Ekholm 1958: 17).

THE DURANGO SEQUENCE

In Durango one preceramic and two ceramic cultures are known. The preceramic Los Caracoles culture belongs with the Southwestern Desert cultures and the continental Archaic stage. The well developed Chalchihuites culture (Mason 1937; Brand 1939; Lister and Howard 1955; Kelley 1956) which extends from southeast to northwest in a narrow band up the eastern edge of the Sierra Madre Occidental represents a peripheral Mesoamerican cultural unit. The poorly known Loma San Gabriel culture appears to have a subsistence pattern based upon minimal farming. The distribution of its simple, but easily identifiable, ceramic and architectural remains indicates a geographical range including both the foothill region and the high Sierra (Kelley 1956; Kelley and Shackelford 1954). It overlaps at least the latter two-thirds of the Chalchihuites occupation of Durango, and apparently survives the demise of the latter, perhaps to become the culture of the historic Tepehuane. However, there is some reason to believe that it may also precede the Chalchihuites culture in the region, perhaps representing the main peasant occupancy of the region subsequent to the earlier hunting and gathering of the Los Caracoles occupation.

The oldest Chalchihuites culture period, the Alta Vista phase, is known primarily from Zacatecas, where it is represented in almost pure form at Alta Vista, Chalchihuites (Noguera 1930; Marquina 1951: 249–52), and in mixed form at the great site of La Quemada (Noguera 1930; Marquina 1951: 243–9). There is some reason for believing that the Alta Vista phase of the Chalchihuites culture may have overlapped and in part grown out of the Late phase of the Chupícuaro culture of Guanajuato.

Ceramics of the Alta Vista phase were traded throughout the Chalchihuites area in Durango, and may have led to the introduction of scrolls, negative bird depictions, and the like in the pottery of the terminal Pioneer period of the Southwestern Hohokam culture. In Durango, the large Schroeder site, located some five miles south of the capitol city, probably was first occupied toward the end of this phase. At any rate, the second period of the culture, the Ayala phase, overlaps the latter part of the Alta Vista phase, and was the time of construction of many structures at the Schroeder site, including the pyramid. The Ayala phase was succeeded in Durango by the Las Joyas phase, strictly a development from the former. The Las Joyas phase, which was also a time of considerable building activity at the Schroeder site, was succeeded by the Río Tunal phase, which was in part an outgrowth of the former, with significant modifications from outside sources, almost certainly including the Three Circle phase of the Mogollon culture of the Southwest. Influences from the same exterior cultural source noted above were also important in the still poorly defined Calera phase, which marks the end of any major occupation at the Schroeder site. This site was abandoned and the Chalchihuites culture had disappeared from the region long before the Spanish conquest.

It is believed that the Alta Vista phase existed between about A.D. 250 and 550, and was approximately contemporary with the full Classic (Teotihuacán III) period of central Mexico. The Ayala phase is tentatively dated at about A.D. 450 to 700, and is thought to overlap late Teotihuacán III and early Teotihuacán IV. It is also tentatively correlated with the terminal Snaketown phase, the Gila Butte phase, and the early part of the Santa Cruz phase of the Southwestern Hohokam culture. Two radiocarbon dates from the Schroeder site are assigned to this phase: M–592, 1150±200 B.P., or between approximately A.D. 600 and 1000; M–613, originally assigned to the Las Joyas phase, but on careful investigation reassigned to the Ayala phase, or earlier, dated 1550±250 B.P., or approximately between A.D. 150 and 650 (Crane and Griffin 1958). The exact significance of the second date is difficult to assess since the sample was included in the fill of an early leveling terrace without ceramic or other diagnostic cultural association. Overlying the leveling terrace was a platform definitely of the Las Joyas phase.

The Las Joyas phase is tentatively dated at A.D. 700 to 950 and is thought to correlate with

FIG. 3. Sinaloa pottery found at the Schroeder site, Durango. *a*, Middle Chametla polychrome; *b*, *c*, Middle Chametla polychrome engraved; *d*, Middle Chametla Black-banded engraved; *e*, Chametla Scalloped-rim decorated; *f*, Chametla Red-rim utility; *g*, similar to Chametla Red-rim decorated (Lolandis Red-rim) and Aztatlán polychrome; *h*, *i*, similar to Cerro Isabel engraved; *j*, Chametla marbelized interior; *k–n* similar to Aguaruto incised; *o*, *p*, Aztatlán ware; *q*, Sinaloa polychrome jar (diameter, 12.5 cm.; height, 19.2 cm.), found in Structure 1 at the Schroeder site intrusive into Río Tunal phase deposits with a transitional Otinapa Red-on-white (Río Tunal phase) — Nevería Red-on-brown (Las Joyas phase) tripod basket-handled bowl, therefore apparently late Río Tunal in age; *r*, Dun fluted; *s*, *t*, similar to Cocoyolitos polychrome.

terminal Teotihuacán IV (Atzcapotzalco) and early Tula (Postclassic), as well as with the Santa Cruz phase (and the early part of the Sacaton phase) of the Hohokam. The Río Tunal phase, in which copper first appears, is believed to date roughly between A.D. 950 and 1150 and to correlate approximately with the full Toltec period of central Mexico, the Sacaton phase of the Hohokam, and the Three Circle phase of the Mogollon in the Southwest. The Calera phase is believed to date between about A.D. 1150 and 1350 and to correlate with Aztec II in the Valley of Mexico and the final phases of the Mogollon in the Southwest.

Correlation of the Sinaloa Sequence with the Chalchihuites Phases

The most firmly established point of correlation between Chalchihuites and Sinaloa sequences calls for equation of the Ayala phase with the Middle Chametla culture of the west coast. Middle Chametla (or Group A) intrusives occur consistently and in quantity in Ayala phase deposits at the Schroeder site (Fig. 3, 5). These include many sherds of Middle Chametla polychrome and Middle Chametla polychrome engraved; sherds of Chametla Red-rimmed utility ware, and its variants, marbelized surface and mano colorada; Chametla white-filleted figurines; and small incised spindle whorls. Also present, but less certainly in Ayala phase association, are Middle Chametla Black-banded engraved and Scalloped-rim decorated. It is possible that a careful re-examination of ceramics from the Middle Chametla deposits would also show Ayala phase (Chalchihuites culture) intrusives, but it is not certain that the Chametla collections have been retained sufficiently intact to make possible such a restudy. Certainly, the Ayala phase of the Chalchihuites culture and the Middle Chametla phase were in close contact and existed over approximately the same time span. There is, however, some slight evidence that the initial part of the Ayala phase may have overlapped terminal Early Chametla, and that terminal Middle Chametla may have slightly overlapped Las Joyas phase.

In terms of their relative positions in their respective sequences, the Alta Vista phase should correlate with the Early Chametla phase, but we have no specific positive evidence for this correlation. Our knowledge of the Alta Vista phase is drawn entirely from brief reports (Gamio 1910; Noguera 1930) and from surface collections and minor tests from Alta Vista. The published materials on both Alta Vista and La Quemada are not sufficiently detailed to allow identification of intrusives, and there are no Sinaloa intrusives in our surface collections from the Alta Vista site. With one possible exception the Chametla report does not show any Alta Vista intrusives. The possible exception is the "cusped foot," supposedly that of a figurine illustrated from Tierra del Padre level 6:6 (Kelly 1938, Pl. 16 *d*), an Early Chametla level. This specimen is almost certainly the foot from a Suchil Red-filled Engraved tripod bowl of the Alta Vista phase. In part at least, perhaps throughout their spans, the Alta Vista and Early Chametla phases must have coexisted.

The Aztatlán complex or horizon is also well represented by intrusives at the Schroeder site. Aztatlán intrusives at Schroeder seem to fall into two groups. One such series (Group B intrusives; Figs. 3, 4, 5) includes Red-rim decorated ware, here termed Lolandis Red Rim ware, in quantity; occasional sherds of Aztatlán ware; Cocoyolitos hollow figurines; large spherical, incised spindle whorls; and somewhat dubiously identified sherds of Cerro Isabel (or Cerro Izábal) engraved and Aguaruto exterior incised wares. All of the Group B intrusive traits are found with the Aztatlán complex at either Chametla or Culiacán (Cerro Izábal and Aguaruto wares) or both, and apparently are not found at Guasave (with the exception of Cerro Isabel engraved and Aguaruto incised). Group B intrusives at the Schroeder site occur primarily in Las Joyas phase deposits, with Lolandis Red-rimmed occurring in considerable quantity. Group B items are also found rarely in Río Tunal phase deposits, where their association is not certain, but in general seems to be different from that of the Group C intrusives to be discussed below. On this evidence the Aztatlán complex would be equated with the Las Joyas phase and perhaps the early Río Tunal phase.

But here the evidence is somewhat contradictory, for a third group of intrusives, Group C, is also identified with the Aztatlán complex (Figs. 3, 4, 6). Group C intrusives include Guasave and Sinaloa polychromes; a rather puzzling group of sherds which have resemblances to Cocoyolitos, El Taste, and Early Culiacán polychromes, but do not conform precisely to the published descriptions for any one of these; notched edge spindle whorls; and copper artifacts. Group C intrusives occur in Río Tunal

deposits, usually in situations where they may be placed quite late in the phase. On this basis the Aztatlán complex would have to be equated with the latter part of the Río Tunal phase, rather than with the Las Joyas phase, a conclusion clearly contradictory to the evidence of the Group B intrusives.

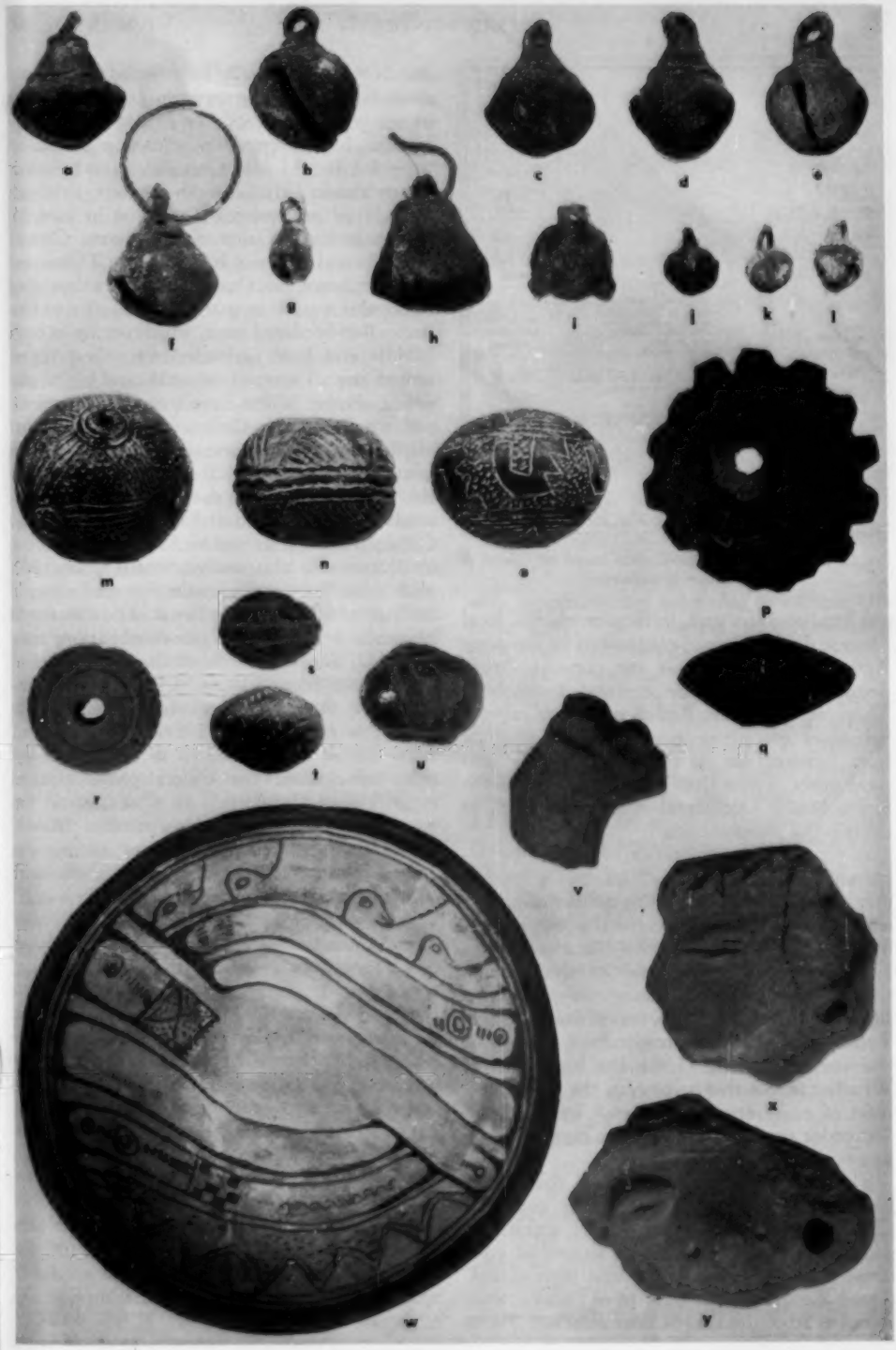
But whereas all Group B intrusives, which occur in Las Joyas phase contexts, are traits noted for the Aztatlán complex at Chametla and Culiacán but only in part at Guasave, the Group C intrusives belong only with the Guasave Aztatlán complex; or in the case of the Cocoyolitos–El Taste–Early Culiacán polychrome sherds with the post-Aztatlán levels at Culiacán and Chametla! It seems clear, therefore, that there is an early Aztatlán complex (which we are here terming the Acaponeta phase) which equates with the Las Joyas phase and probably with the early Río Tunal phase; and a late Aztatlán complex (here termed the Guasave phase) which equates with the late Río Tunal phase (and perhaps with the early Calera phase as well). Obviously, further study of the Aztatlán complex on the west coast is needed to check this Durango evidence.

The mode of occurrence of Lolandis Red Rim (Red-rim decorated) ware at the Schroeder site presents certain problems. In Structure 7, the ceremonial precinct at the foot of the Schroeder site pyramid, only three Lolandis sherds were found. Since this structure is virtually a pure Ayala phase component, producing much Middle Chametla trade ware, we may conclude that Lolandis did not appear at the Schroeder site until the Las Joyas phase. The Ayala phase ball court, Structure 6, produced only five sherds of Lolandis and these may well be later intrusions. On the other hand, in the Las Joyas phase deposits at Structure 5, the major part of which was constructed and first occupied during the Ayala phase, some 256 sherds of Lolandis Red Rim were found, representing nearly 28% of the decorated ware from the structure (data from 1956 excavations). Actually, it is the dominant decorated ware of the Las Joyas phase there, since Nevería Red-on-brown, normally regarded as the diagnostic ware for the phase, represented only some 21% of the decorated ware. But at Structure 2, which was built during the Ayala phase, less than 5% of the decorated ware was Lolandis Red Rim and 15% was Nevería Red-on-brown. These latter sherds may pertain to later debris deposited around Structure 2 after abandonment and during its use as a cemetery area.

Other structures occupied during the Las Joyas phase also produced Lolandis Red Rim ware in some quantity, although usually in smaller percentages than in Structures 2 and 5. Incomplete figures from the 1954 and 1956 sessions report at least 490 sherds of Lolandis ware from the Schroeder site excavations. However, Kelly found only 121 sherds of Lolandis (Red-rim decorated) at Chametla and only 167 sherds of the ware at Culiacán. From such statistics one might conclude that Lolandis is a Durango ware intrusive in the Sinaloa sites, rather than the contrary but orthodox assumption.

Tempting as such an assumption appears, it is not borne out by other evidence. Sauer and Brand (1932, Figs. 4, 5) found this ware ("Decorated Red-rimmed Red-on-buff") to be widely distributed in Sinaloa, and their table shows it to be the most common decorated ware in their collections (represented by 575 sherds, or over 37% of all decorated wares). These figures may be somewhat misleading, since, according to Kelly (1938: 19), they included in their count some "decorated red-rimmed utility ware." Nevertheless, Lolandis Red Rim is well represented and perfectly at home in Sinaloa, while its distribution in Durango is limited, spotty, and numerically insignificant in terms of the total ceramic complex. Furthermore, Lolandis Red Rim apparently developed out of red-rimmed utility ware, a basic ware in the Sinaloa ceramic development (appearing with the earliest Chametla polychrome) and in turn developed into Aztatlán ware. In Durango, on the other hand, it appears suddenly, without obvi-

Fig. 4. Sinaloa pottery and other artifacts found in Chalchihuites sites in Durango. *a–l*, copper artifacts from Navocoyán in the Schroeder collection, similar to those found in smaller quantities in Río Tunal and Calera phase deposits at the Schroeder site (*a*, 2.9 by 3.5 cm.; others to scale); although similar to specimens found in Guasave and Middle Culiacán deposits in Sinaloa, the direction of trade is not known; *m–u*, types of spindle whorls from the Schroeder site that are either trade items from Sinaloa or local copies of them (*m*, greatest diameter, 3.8 cm.; others to scale): *m–o*, Early Aztatlán (Lolandis or Acaponeta phase) type whorls from Chametla; *p*, *q*, whorls with edge-notching like Aztatlán whorls at Guasave; *r–u*, small Chametla-horizon type engraved whorls; *v*, Culiacán type whistle from the Schroeder site (height of fragment, 3.5 cm.); *w*, Lolandis Red Rim (red-rim decorated) bowl from Navocoyán (diameter, 26 cm.); *x*, Cocoyolitos hollow figurine from the Schroeder site (width of fragment, 7.5 cm.); *y*, Chametla white-filleted figurine from the Schroeder site (width of fragment, 10 cm.)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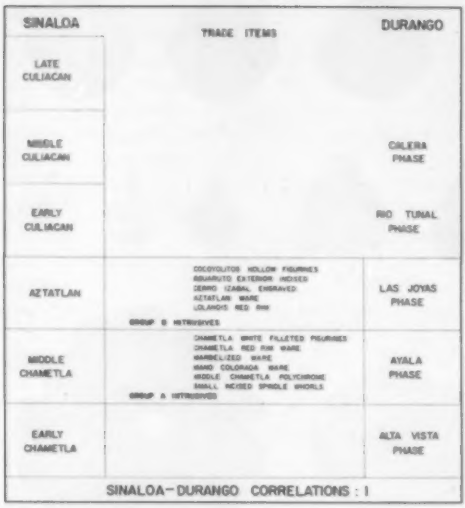

Fig. 5. Sinaloa-Durango correlations based on Group A and Group B intrusives.

ous local ancestry and, in fact, breaks the local ceramic developmental continuum by replacing Amaro Red-on-cream as the popular simple decorated bowl in the ceramic assemblage. Thus, the Lolandis Red Rim sherds at the Schroeder site are to be regarded as intrusives from Sinaloa, but on such a large scale that some other process than simple trade across the Sierra Madre Occidental must be invoked to explain the phenomenon.

A second item of interest regarding the occurrence of Lolandis Red Rim in Durango is that its west coast companion pottery, Aztatlán ware, is very sparsely represented at the Schroeder site. Furthermore, there is some very slight evidence that the few Aztatlán ware sherds that do occur at the Schroeder site may be assignable to the late Las Joyas or the early Río Tunal phases, while Lolandis itself appears at the very beginning of the Las Joyas phase. Whether or not this be correct, the differential ratio of occurrence of the two wares at the Schroeder site suggests that they may not have identical time spans in Sinaloa.

The evidence for correlation of the Calera phase of Durango with the Middle and Late Culiacán phases in Sinaloa is very scanty. In general they fall into the same sequential positions; they are post-Aztatlán and preconquest. Three sherds of Dun ware from Sinaloa were found in Structure I at the Schroeder site. These sherds cannot certainly be assigned to a phase there, however. They appear to be Calera phase in age but may actually be of Río Tunal association. In Sinaloa, Dun ware is a diagnostic ware for the Middle Culiacán period, but it occurs also in Late Culiacán deposits, although in reduced percentages, and even in rare instances in Early Culiacán association. One of the principal wares of both the Río Tunal and Calera phases, in Durango is Canatlán Red Band; this ware is in many ways similar to Culiacán Red-bordered ware, which occurs in both Middle and Late Culiacán but is best represented late. There is one additional bit of evidence. Nayar White-on-red, one of the principal wares of the Calera phase, is almost identical with a white-on-red ware occurring in quantity in Nayarit. Gifford (1950) found that this ware followed in time an Aztatlán-like assemblage and he equated it roughly with the Culiacán horizon in Sinaloa. Kelly (1938, Pl. 6 *c*) illustrates a white-on-red bowl ("probably a trade piece") from Chametla that undoubtedly belongs to this group of wares. The Chametla specimen is late, but no closer affiliations may be stated, since it came from the upper level of Cocoyolitos Mound A, which has El Taste-Mazatlán, Aztatlán, and even some Middle Chametla materials. In general, however, all these bits of evidence seem to add up to the same conclusion: the Calera phase equates roughly with Middle or Late Culiacán on the west coast, more probably with late Middle Culiacán, since the Chalchihuites culture was apparently long gone from Durango at the time of the Spanish conquest.

In summary, Middle Chametla and the Ayala phase correlate closely, and the Alta Vista phase probably correlates with Early Chametla; the Aztatlán complex correlates roughly with the Las Joyas and the Río Tunal phases, but the Aztatlán types appear at varying times in Durango, rather than all at once; and finally, there is a rough correlation between the Calera phase and the Culiacán horizon, probably the Middle Culiacán period. Thus, the Durango evidence verifies the sequence of Chametla, Aztatlán, and Culiacán horizons on the west coast, but suggests that the Aztatlán horizon is probably made up of two or three separate complexes which have temporal significance (Fig. 6). To properly evaluate this latter point, it is necessary to review the evidence for the Aztatlán horizon, as known in Sinaloa.

THE AZTATLÁN HORIZON IN SINALOA

The Aztatlán horizon in Sinaloa is known from excavated sites near Chametla, in the lower Baluarte River valley in southeastern Sinaloa; from excavated sites near Culiacán, in the lower Culiacán River valley in north central Sinaloa; from the excavated mound at Guasave, on the lower Sinaloa River in extreme northwestern Sinaloa; and from surface collections made at a number of sites distributed throughout the Sinaloa coastal plain and to the south in Nayarit.

Inasmuch as one receives the general impression that the Aztatlán horizon in the various localities is all very much alike (Ekholm [1942: 124] speaks of "the widespread uniformity of culture in Sinaloa during the time of the Aztatlán complex. . . .") it comes as a considerable surprise to discover that this is not at all the case. In Figure 7 we have attempted a graphic analysis of the Aztatlán ceramic complex in Sinaloa. It is at once clear that the only pottery types common to the horizon at all three principal localities are the utility red-brown wares and polished red and black wares — which are also found in other horizons as well. Lolandis Red Rim (Red-rim decorated) occurs at both Chametla and Culiacán (although it is somewhat different in the two localities) and Guasave Red-on-buff at Guasave is related to this ware. Ekholm (1942: 48) says: "According to Doctor Kelly it [Guasave Red-on-buff] is similar in color and in the plan of exterior decoration to the Culiacán red-on-buff [Lolandis Red Rim] but could never be confused with that ware." Aztatlán ware occurs at both Chametla and Culiacán, and Ekholm (1942: 52) notes that the general plan of design of Aztatlán polychrome from Guasave is similar to that of Aztatlán ware but he adds: ". . . Aztatlán ware is . . . a cruder, simpler ware than. . . . Aztatlán polychrome. . . . found only at Guasave."

Culiacán and Guasave share Navalato polychrome and Aguaruto incised, but both wares are missing at Chametla. There is apparently some relation between Kelly's Cerro Izábal engraved from Culiacán and Ekholm's Cerro Isabel engraved ware at Guasave, but Ekholm notes that only one bowl of Cerro Isabel was recognized by Kelly as conforming to her equivalent Culiacán type; Ekholm's ware includes a much greater range of one-color painted wares

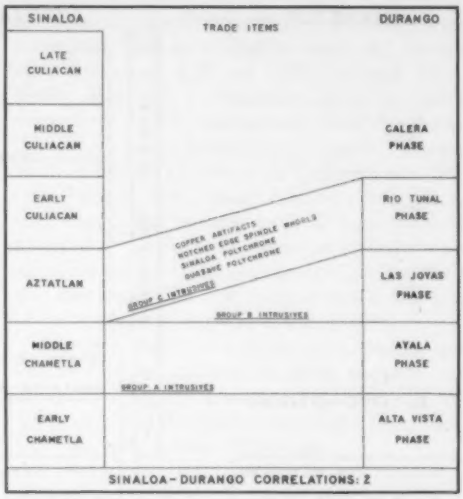

FIG. 6. Sinaloa-Durango correlations modified by Group C intrusives.

with supplementary engraving or incising (Ekholm 1942: 56). Nothing corresponding to either ware has been reported from the Aztatlán horizon at Chametla.

Furthermore, each Aztatlán locality has its own local ceramic types; Cocoyolitos polychrome and Black-on-buff ware at Chametla; Alamitos engraved, Cerro Izábal engraved, Aguaruto polychrome, and "coarse Aztatlán ware" at Culiacán; while no less than nine well developed polychrome types, two incised types, one engraved ware, and one red-on-buff ware are found only at Guasave. In terms of ceramics, Chametla and Culiacán appear most closely related during the Aztatlán horizon, Guasave most divergent. Chametla appears to have the simplest expression of the Aztatlán horizon; Culiacán next; and Guasave is the richest of all. Furthermore, one gets the impression that development is implied here; many of the ceramic traits that are so richly represented at Guasave appear to be elaborations on simpler forms present at Chametla and Culiacán.

With regard to other cultural traits, the situation is somewhat similar, as the following incomplete comparison will indicate. Common to all three major Aztatlán localities are such traits as: extended inhumation, secondary bundle burials, olla burials, burial mounds (?); ¾-grooved stone ax, flat slab metate, mano with

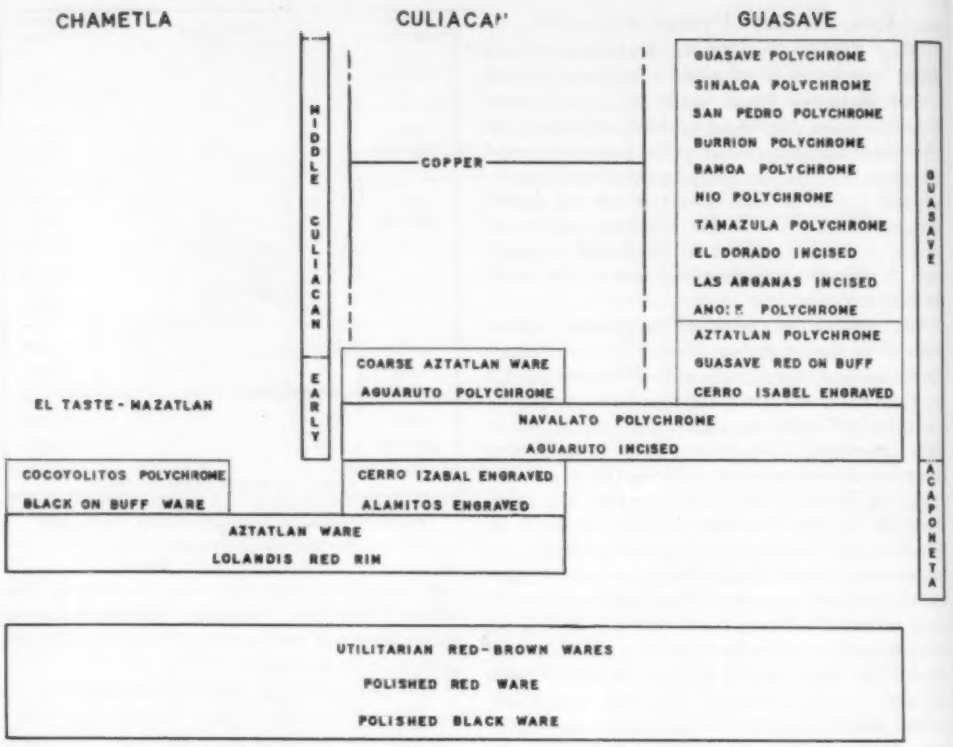

FIG. 7. Graphical analysis of the Aztatlán horizon in Sinaloa.

overhanging ends, metates with four nubbin feet (?); platform elbow pipes of clay, both plain and incised; incised clay spindle whorls, conic shaped whorls; clay whistles; cylindrical clay stamps (?). Common to Chametla and Culiacán but not occurring at Guasave are: two-hand (?) loaf-shaped manos. Common to Culiacán and Guasave, but not found at Chametla are: filing of human teeth, stone effigy axes, flat slab axes or celts, four pointed stone crosses ("quatro vientos"); clay pottery masks, animal effigy pipes with legs; bi-lobed shell beads (Hohokam type), disc shaped beads, and shell bracelets. A number of traits are noted for Guasave only, including iron pyrites beads, onyx and alabaster vessels, stone pipe, discoidal beads, "medicine stones," stone shaft polishers, stone rings, polishing stones, stone balls, slate whetstones, notched pebbles, turquoise pendants and beads, turquoise mosaic work; rectangular engraved clay plaques; many items of shell, including carved beads, globular beads, tubular beads, tinklers, circular plaques, mosaic units; pierced shell necklace; painted, cloisonné-decorated gourds; trophy heads; status mound burial with rich offerings, platform, wood cover; bells, rings, ear spool, necklace of copper.

In addition, there are specific differences between types common to all three divisions. Thus, Culiacán and Guasave Aztatlán share certain spindle whorl types; the Chametla type is considerably different. Here again, Chametla appears simple, poor; Culiacán somewhat richer; Guasave rich, elaborate. In nonceramic traits there does appear to be a basic complex for the Aztatlán horizon, and Culiacán and Guasave resemble each other more closely than either resembles the simpler manifestation of the horizon at sites such as Chametla. It should be noted that a basic agricultural economy, use of perishable houses and temples of jacal and adobe, lack of stone masonry (and associated stairs, columns, pyramids) appear to be common to the horizon.

Archaeologically speaking, however, the differences between Aztatlán units are numerous and pronounced, especially between Guasave Aztatlán and that of other localities. To what may such a pronounced variability be attributed? Ekholm suggests that the richness of Guasave arises out of the fact that it was a burial mound with rich mortuary furniture further embellished by the accretion of a great variety of ceremonial traits of Mixteca-Puebla origin to earlier established west coast complexes. The Aztatlán materials from Culiacán, he notes, came, on the other hand, largely from excavations in rubbish heaps, "... and very few burials with accompanying objects were found" (Ekholm 1942: 123). Ekholm believes also that the Guasave site represents a very short occupation since he found no significant changes in culture from the deepest to the shallowest burials.

On the other hand, Kelly (1945: 119) saw "some suggestion of time difference within the Aztatlán complex itself" at Culiacán. This evidence seemed to indicate that Navalato and Aguaruto polychromes, Black-and-red rimmed, and Aguaruto incised wares persisted after the disappearance of (fine) Aztatlán ware, Red-rim decorated, Cerro Izábal engraved, and Alamitos engraved (Kelly 1945: 120).

The Durango evidence previously cited would seem to indicate that the Guasave materials represent a later Aztatlán occupation than those from Chametla, and probably those from Culiacán as well. The differences in content of the various Aztatlán units would then be interpreted as variations resulting from developments of the complex through time. As already noted, the Guasave association looks like an elaborated and evolved Chametla complex, with Culiacán Aztatlán intermediate between the two. The greater richness of Guasave would then be explicable as the results of continued evolution of the ceramics and other material traits, producing local forms and elaborations, plus accretions through diffusion or migration, or both, from (a) Central Mexico (the Mixteca-Puebla elements identified by Ekholm) and (b) the Southwest (including items such as shell bracelets, shaft smoothers, stone pipes). Ekholm's explanation of the elaborate Guasave material as representing ceremonial burial items not present in other Aztatlán sites does not appear fully tenable, although some such selective factor may be relevant. Thus, at Guasave 166 burial units, plus 21 fragmentary skeletons were excavated, but at Culiacán over 262 burials were excavated (252 in 1935; at least 10 in 1939). But such a comparison is not accurate, since these burials represented both the Aztatlán and Culiacán horizons at Culiacán. Assignment of burials to periods at Culiacán was difficult, because little burial furniture was placed with them. But at least some 30 burials can be assigned to the Aztatlán complex, probably considerably more of the unassignable ones as well, and this should be sufficient to give a fair idea of the ceremonial content of the culture.

Actually, there is evidence at Culiacán and Guasave to substantiate in large measure our inference from the Durango data that the differences in the Aztatlán assemblages from these localities reflect time differences.

1. Two Aztatlán pottery types, Navalato polychrome and Aguaruto incised, of the four wares which Kelly believed to be late Aztatlán at Culiacán (overlapping both Early Culiacán and the beginnings of Middle Culiacán) are the only two wares of the complex there which likewise are well represented and identical at Guasave. The other two late Aztatlán wares which survive late at Culiacán (Aguaruto polychrome, black-and-red-rimmed), plus the late coarse variant of Aztatlán ware proper, are local Culiacán developments not appearing at either Chametla or Guasave.

2. At Guasave, Ekholm found that extended inhumation with head to the south, and accompanied by little if any mortuary furniture, represented the earliest burial type. Only two identifiable pottery vessels were found with burials of this type. One of these was identified as Guasave red-on-buff, which appears to be a more elaborate and evolved form of the Lolandis Red Rim ware group; the other, as Aguaruto incised (Ekholm 1942: 42).

3. Copper artifacts appeared first in the Middle Culiacán phase at Culiacán, but were part of the general Guasave complex. They were not present at all in the Aztatlán assemblages at Chametla or Culiacán.

4. The Guasave pottery types which resemble Aztatlán types elsewhere (Guasave red-on-buff — Lolandis Red Rim; Cerro Isabel engraved — Cerro Izábal engraved; Aztatlán polychrome — Aztatlán ware) appear to be elaborations and later development from their more widespread and basic counterparts.

5. The elaborate polychrome vessels and types from Guasave look more like the elaborate and colorful Culiacán polychrome wares than the simpler and plainer Aztatlán wares at the latter site and elsewhere.

We interpret these data as follows: The only Aztatlán wares at Guasave which are clearly identifiable with those found in other Aztatlán sites are those which are late Aztatlán at Culiacán and not present at all in the simple Aztatlán of Chametla. One of these wares, Aguaruto incised, is demonstrably late Aztatlán at Culiacán, while it is one of two wares demonstrably early at Guasave. The late Aztatlán wares at Culiacán appear to be contemporaneous with Early Culiacán, or even to overlap early Middle Culiacán. Therefore, the early use of the Guasave burial mound should coincide in time with the late Aztatlán and Early Culiacán complexes at Culiacán. The full development of the Guasave mound therefore should be at least in part contemporary with the Middle Culiacán occupation to the south, bringing the Middle Culiacán and Guasave copper occurrences in line with the presumption that copper had not appeared on the west coast during the Aztatlán occupation at Chametla and the early Aztatlán period at Culiacán, as well as equating the florescent polychrome wares of the two cultures. These conclusions are strictly in line with the Durango evidence, and clarify several contradictions in west coast culture history.

However, certain contradictory data should be mentioned also. The earliest burial practice at Guasave, as noted, is extended inhumation with head to south with few burial accompaniments. Of later occurrence is extended inhumation with head to north with relatively rich burial furniture in association with secondary olla burial. But at Culiacán extended inhumation with head to north with few accompaniments, in association with olla burial, seems to characterize the basic Aztatlán occupation there. Taken at face value this would indicate, on the basis of orientation and presence of olla burials, that the Aztatlán complex burial customs of Culiacán were late at Guasave, in contradiction to the evidence earlier presented. But because lack of mortuary furniture was early at Guasave, and inasmuch as olla burial occurred even earlier in the Middle Chametla period at Chametla, the significance of the burial data is somewhat uncertain. Also of some concern is the lack of intrusive, specifically Guasave pottery in Early and Middle Culiacán deposits and vice versa. Kelly (1945: 8) notes one probable Guasave pot at Culiacán, but without cultural association. The same situation relative to trade relations existed in Durango where both the Aztatlán and Chametla horizons are represented by numerous trade specimens, the Culiacán horizon hardly at all, suggesting that cultural (perhaps political) factors rather than time are involved. These contradictions do not appear sufficiently strong to offset the Durango and Sinaloa evidence for correlation previously presented; they do suggest, however, that the situation may be considerably more complicated than here considered.

The Sinaloa evidence, then, in general substantiates the Durango evidence that the Aztatlán complex at Guasave (here termed the Guasave phase) is largely later than the same complex at Culiacán, from which it was probably derived. Presumably the Culiacán Aztatlán and the Chametla Aztatlán assemblages are closer to the widespread west coast Aztatlán complex, which we are here terming the Acaponeta phase. Essentially, the Acaponeta phase is identified ceramically by the repeated association of Aztatlán ware with Lolandis Red Rim (Red-rim decorated) ware.

There is also evidence in Durango that Lolandis occurred there largely without Aztatlán ware, and some slight evidence that the situations in which the two occurred together were later than those in which Lolandis appeared alone. If so, there should be situations in Sinaloa also where this ceramic segregation and stratigraphy is evident.

Kelly (1938: 38) notes that collections made by Sauer and Brand at the Lolandis site in the Acaponeta valley feature Lolandis Red Rim (Red-rim decorated) as the only painted ware. Examination of the Sauer and Brand (1932, Fig. 5) survey data shows that Lolandis Red Rim occurs without Aztatlán ware in twelve sites and in association with Aztatlán ware in nine sites; whereas Aztatlán ware never occurs without Lolandis. At Chametla, Kelly (1938: 36) found Lolandis (Red-rim decorated) to be genetically basic to the other wares of the Aztatlán complex. Such a conclusion seems typologically accurate; essentially Aztatlán ware was created by the addition of an incised or engraved geometric "sky band" on a white background, of a presumptive Aztec I — Tula-Toltec origin, to the exterior of interior decorated Lolandis

bowls. Kelly (1938: 40) also noted that at Cocoyolitos Mound A both of the two stratigraphic levels contained Lolandis Red Rim (Red-rim decorated), but that in the deepest (and earliest) level the red rimmed ware occurred without Aztatlán ware association. Kelly's sherd distribution figures verify this earlier appearance of Lolandis and also suggest some overlap of this ware with Middle Chametla polychrome. By grouping the Sauer and Brand sites in which Lolandis Red Rim occurs alone into one group, and those in which it occurs with Aztatlán ware into a second group, certain significant distributions of the associated wares are notable. In the first group, in which Lolandis represents some 50% of all sherds found, the earlier Chametla polychrome wares (undifferentiated) are represented by about 7% of the sherds, the later Mazatlán and Culiacán polychromes by approximately 4% and 3% respectively. But in the second group, where Lolandis accounts for approximately 48% and Aztatlán 10% of all sherds, Chametla polychrome (undifferentiated) still accounts for some 7% of the sherds, but the later Mazatlán and Culiacán polychromes represent 10% and 7% respectively of all sherds. In other words, pure Lolandis sites (that is, those lacking Aztatlán ware) show a relatively stronger association with earlier wares; mixed Lolandis-Aztatlán sites show a relatively stronger association with later wares. It appears certain that there was an early period in the development of the Aztatlán horizon in which Lolandis Red Rim ware was the dominant decorated ware, and a later period in which the two occur together.

The Revised Sinaloa Sequence

The results of the arguments presented above may now be synthesized into a revised Sinaloa sequence. The basic sequence of Chametla, Aztatlán, and Culiacán complexes remains unchanged, and has in fact been verified both by the new Durango data and the conclusions derived from a critical resurvey of the Sinaloa evidence. However, there is some evidence for a temporal overlap of these basic cultural complexes, here termed the Chametla, Aztatlán, and Culiacán horizons. Furthermore, the new data are in agreement with the sequence of Early Chametla (here termed the Tierra del Padre phase, after Kelly's most important Chametla horizon site) to the Middle Chametla (here termed the Baluarte phase) polychrome complexes.

Considerable revision of the Aztatlán horizon was found necessary. The once putatively homogeneous complex has been divided into three largely sequential assemblages from early to late: the Lolandis, Acaponeta, and Guasave phases. It is believed that there may be a slight overlap between the initial Lolandis phase and the earlier Baluarte phase (Middle Chametla) from which it may have developed; and between the late Guasave phase and the first two phases of the Culiacán horizon. Although no new data relating to the divisions of the late Culiacán horizon are available, its early, middle, and late divisions have been termed, respectively, the La Divisa, Yebalito, and La Quinta phases (after various Culiacán survey sites reported by Kelly), for the purpose of consistency in terminology. The revised Sinaloa sequence is summarized in Figure 8, with the somewhat variant Huatabampo and Tacuichamona cultures shown in their apparent respective positions relative to the general Sinaloa sequence.

Perhaps a note regarding terminology is needed at this point. In her last Sinaloa report Kelly (1945: 115, footnote 46), discusses the possibility of further elaboration and shifting of the Culiacán chronology and adds:

> The possibility of shifts in chronology immediately brings to mind the snarl in terminology that would result. Since the report was written, I have spent two years at Gila Pueblo, where chronology is by phase, each phase named without commitment to its position in any chronological scheme. Such incautious terms as "Early" or "Late" are thus avoided. The flexibility of such a system is obviously invaluable. If, eventually, material contemporaneous with the early deposits of Chametla is found at Culiacán, an awkward situation will result, for such material will be "pre-Early" according to the present designations. Had the clerical labor of changing the terminology throughout the report not been insurmountable, the Pueblo phase system would certainly have been adopted. But the present designations will have to remain, at least until the fatal day when "pre-Early" or "post-Late" materialize.

It is our impression that Kelly's "fatal day" (terminologically speaking) has now arrived, although not precisely as she visualized it. Since we are in complete agreement with the beliefs expressed in her statement, we have taken advantage of this opportunity to revise the terminology as well as the cultural sequence of the Sinaloa cultures, dropping all terms expressing chronology and substituting for them phase names derived from local site names or geo-

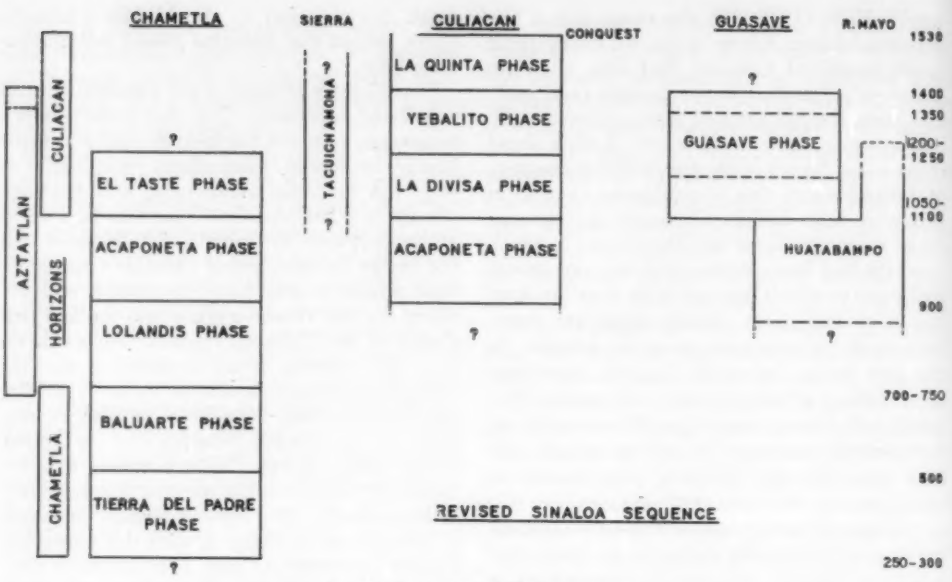

Fig. 8. The revised Sinaloa sequence.

graphic features. For the major divisions, such as horizons and stages, we have retained the familiar broad Sinaloa terminology.

With some timidity we have included tentative dates on our revised sequence chart. Space does not allow full discussion of the basis for the dates used, but they are derived from correlation of the combined Sinaloa-Durango sequences with the Central Mexico chronology and that of the American Southwest. In general we regard the Tierra del Padre phase as equivalent in time to the latter two-thirds of Teotihuacán III, the appearance of spindle whorls in the intermediate levels of the Tierra del Padre phase corresponding to their appearance in the Tlamimilolpa phase of late Teotihuacán III. The Baluarte phase began at or near the very end of Teotiuacán III, and in general can be correlated with Teotihuacán IV (Atzcapotzalco). We consider the appearance of Lolandis Red Rim ware to be related to the appearance of Coyotlatelco ware in Central Mexico, an opinion shared, more or less, by Kelly (1938: 2, note 3; 1945: 8) and Ekholm (1942: 48–9).

We believe that the traits that turned Lolandis Red Rim into Aztatlán ware were derived, not too much later, from a Tula-Toltec — Aztec I source in the valley; and that the Mixteca-Puebla elements noted by Ekholm in the Guasave materials (and to a lesser extent in the Acaponeta phase Aztatlán at Culiacán) derive from developments in late Aztec I and in Aztec I–II. However, it now appears that Aztec I and Tula-Toltec were more or less parallel and contemporaneous developments, and that Aztec II had appeared sufficiently prior to the fall of Tula (about A.D. 1168, or roughly 1150) to represent the common decorated ware of the conquerors of that center (for some discussion of these points see Acosta 1956–57; Covarrubias 1957: 276–80, 321–32). The full Culiacán and latest Guasave materials clearly equate with Aztec II–IV, and were terminated by the Spanish conquest in A.D. 1530. This southward correlation is supplemented by a northward correlation of the Durango-Sinaloa sequence with that of the American Southwest, but this will be discussed in subsequent papers.

With regard to actual year dates, the situation is even more complex. Dates for the Spanish conquest in the Valley of Mexico (1521) and Sinaloa (1530), plus the traditional dates for the destruction (1168) and founding (variously interpreted as A.D. 752 to 908) of Tula, and the widely accepted radiocarbon date of about 100 B.C. for the ending of the Preclassic and the beginning of the Teotihuacán Classic sequence, provide chronological landmarks only. Between

these, granting that they may be approximately correct, one must arrive at dates for the various cultural periods more or less by guesswork, inasmuch as correlations with the Maya calendric sequence involve problems of both cultural and calendrical correlation that are not yet resolvable. In selecting the guess-dates employed here we have also been somewhat influenced by the Southwestern datings and have even allowed these (and our correlations of Southwestern and Mesoamerican sequences) to color our choice of Central Mexican dates. We take it for granted that users of our chart will take these factors into full account and not be overly influenced by the dates shown.

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CHRONOLOGY AND CULTURE CHANGE IN THE SAN JUAN ISLANDS, WASHINGTON

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ABSTRACT

The archaeological sequence in the San Juan Islands is known best from two phases: the Marpole phase which occurs within the first millennium B.C., and the San Juan phase which lasts from at least A.D. 1300 to historic times. More difficult to place culturally and chronologically are: (1) the previously excavated bluff areas of Cattle Point which contain components similar to Whalen I and II and would thus occupy the time period between about 500 B.C. and A.D. 400; and (2) the Argyle Lagoon site which, though early, cannot be related definitely to other components because of insufficient excavation. Culture change is shown by increasing maritime adaptation through time and by the gradual replacement of the chipped stone industry by one using abrading and polishing techniques as the result of influence from the Old World.

ARCHAEOLOGICAL excavations at nine sites in the San Juan Islands (Fig. 1) permit (1) the formulation of the San Juan phase which includes components from Jekyll's Lagoon, Turn Point, Lime Kiln, Moore, Mackaye, and Cattle Point, and which is identifiable with the culture of the Salish Indian groups who occupied the islands in historic times, and (2) the grouping of the Garrison site and part of the assemblage from the Richardson site into the Marpole phase. Additional components from Argyle Lagoon and Cattle Point are early, but are difficult to relate to the other phases found in this area. The terms used by King (1950) to designate phases of the Cattle Point site are not used here as they imply a certain developmental sequence that is somewhat controversial. Phases with geographic names remedy this situation.

The archaeology of the Fraser delta, the San Juan Islands, and Puget Sound constitutes a reasonably unified whole. The firmest local chronology that has bearing on our subject is that established by Borden for the sites on and immediately adjacent to the Fraser delta just to the north of the San Juan Islands, but which is not yet in print. The components from the Point Grey, Beach Grove, and Marpole sites group into the Marpole phase which has an average radiocarbon date of 662 B.C. based on dates from the Marpole site. The component from the Garrison site to be discussed in this paper ties in well with this phase because of the presence of the Marpole-type barbed antler harpoon, the general use of antler as opposed to bone for making barbed projectile points, the stone adz blades finished on one side only, stone carving, the well developed art style, and the emphasis on chipped stone projectile points. Part of the assemblage from the Richardson site belongs to this phase also.

Another early phase that Borden has isolated is that found at Locarno Beach and as the lower of two components at the Whalen site. Radiocarbon dates are 476 B.C. for the former and 493 B.C. for the latter (Daugherty 1958: 454). The typical implements from this phase are large, faceted, ground slate points; toggling harpoon heads either composite or one piece; faceted ground bone points; an advanced art and probably ceremonialism; and heavy ground slate points. In the San Juans these traits occur only in the bluff areas of Cattle Point, but somewhat different artifactual associations are reported (King 1950), however, which may indicate temporal or cultural differences or mixture of elements.

The upper component at the Whalen site has a date of A.D. 377 (Daugherty 1958: 454). The artifacts common there are numerous chipped stone points, obsidian microblades, ground adz blades, two-piece toggles and other items (Borden 1950). There is the suggestion of relationships with part of the Cattle Point sequence, particularly the "Maritime" phase, but more information is needed to define it adequately.

The San Juan phase is, for all practical purposes, identical with the Late phase on the Fraser delta (Borden 1950, 1951) with the Penn Cove phase from the Skagit-Whidbey area (Bryan 1957) and with the component from Old Man House in Puget Sound (Snyder 1956). This is essentially Northwest Coast culture as it is known ethnographically from this area. Archaeologically it is definable by the virtual absence of chipped stone artifacts, and the presence of unbarbed and unilaterally barbed bone projectile points, bone barbs for composite fish hooks, small composite toggle heads, numerous wood working tools at winter village sites, and by a settlement pattern involving permanent winter villages of plank houses coupled with

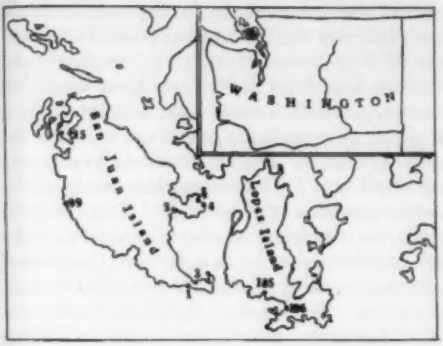

FIG. 1. Map of San Juan and Lopez Islands showing location of the following sites: *1*, Cattle Point; *2*, Argyle Lagoon; *3*, Jekyll's Lagoon; *4*, Turn Point; *5*, Moore; *25*, Garrison; *99*, Lime Kiln; *185*, Richardson; *186*, Mackaye.

numerous summer camp sites. This phase was apparently in full swing by A.D. 1300 as Borden has a radiocarbon date of 660±130 B.P. for the beginning of the village of Tselax at Musqueam.

MARPOLE PHASE SITES

The Marpole site located on the Fraser delta to the north of the San Juan Islands was investigated years ago by Harlan I. Smith (1903) and Charles Hill-Tout (1895) and was referred to as either the Eburne mound or the Great Fraser Midden. Recently it has been reinvestigated by Charles Borden (1950, 1951) although few of the recent data are in print. Two sites in the San Juans, Garrison (SJ–25) and Richardson (SJ–185), show ties with the Marpole site. Marpole itself shows a highly developed culture, climactic in character, with an elaborate cultural inventory. The average of two radiocarbon dates run by the University of Saskatchewan for Borden is 662 B.C. Both dates are from the same sample of charcoal and are respectively 943 and 381 B.C. There are some differences between the Marpole site and these two San Juan sites which are probably due to the marginal position of the latter in relation to Marpole and to a smaller sampling.

Garrison

Garrison (SJ–25) is a shell midden located approximately 400 yards to the west of the English Camp blockhouse on a small point of land which juts out into Garrison Bay. Garrison Bay is one of two large sheltered bays on the northwest side of San Juan Island which have mud flats containing extensive beds of shellfish. An English garrison occupied the area east of the site in the 1860's during the boundary dispute between Britain and the United States. The chief remnants of the English occupation are the blockhouse, which is presently being undercut by wave action, and numerous fragments of heavy, dark green, wine bottles which are scattered along the beaches of the bay. A large shell midden (SJ–24), which was partially excavated in 1950 under the direction of A. E. Treganza, covers the area occupied by the English camp. Shell deposits are almost continuous between the two sites. The northern part of San Juan Island, probably Garrison Bay, is the legendary home of the ancestral group of the Lummi and Songish and possibly the Saanich (Suttles 1951: 33–6).

The Garrison site extends about 400 feet along the shore and marks its greatest depth at the point where test pits indicated a depth of at least 3 feet below the beach level, and that the elevation of the point itself is probably wholly artificial. The deposit extends back from the beach for approximately 100 feet and extends up over what appears to be a wave cut terrace. The point itself is at present beach level, whereas the midden to the east and west is on top of a wave cut bank from 5 to 7 feet above the present beach level. Surface cover of the site consists of different grasses and blackberry vines, madrona trees up to 6 feet in diameter, and a number of small conifers under 2 feet in diameter. Evidences of former trees growing in the midden were uncovered during excavation. The eastern portion of the site was tested with three connected trenches and two additional test pits (Fig. 2).

The stratification (Fig. 3 *b*) shows that occupation began on the upper levels. Evidence of a precultural vegetation is limited to a few thin patches of gray modified subsoil above the sterile yellow clay. The first layer (Ia) is made up of modified subsoil, some shell fragments, and a few artifacts. In some areas it is capped by yellow clay borrow dirt from pits excavated through it during the deposition of the second layer (Ib), which is essentially a layer of compacted whole shell and black dirt. Prior to the build-up of Layer Ib one large pit and one trench had been excavated into the subsoil. Layer Ib is the first shell layer in these features as well as the first layer of shell above the material excavated from them. The nature of the

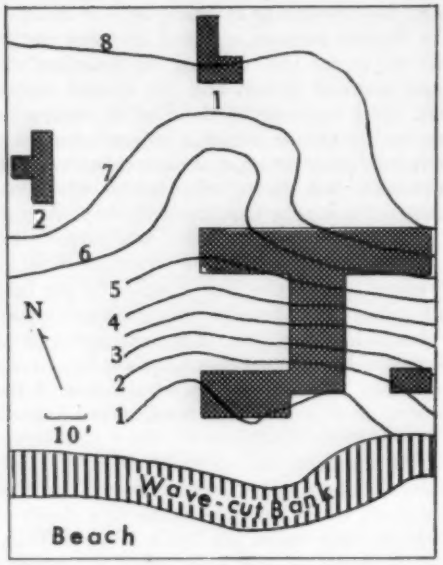

Fig. 2. Plan of main excavation and Test Pits 1 and 2 at Garrison.

shell in Layer Ib does not indicate intensive use of the site which seemingly would have resulted in greater fragmentation of the shell, but suggests rapid accumulation followed by disuse. Dormancy of this portion of the site after the deposition of Layer Ib is indicated by a layer of brownish silt which is probably wash from up slope and which merges with some of the upper portions of this deposit. A large tree stump overlies portions of this layer and its root system has considerably disturbed the stratification. A thin deposit of charcoal overlying some portions of this layer may be an indication that the site was burned over. Neither Layers Ia or Ib are present in the southern part of the excavation where a layer of gray silt (Ic) containing the remains of former bushes and rotted out trees occurs immediately above the subsoil. Layer II, which overlies Layer I in northern part of the main excavation, consists of a fairly homogeneous mass of black dirt, silt, fragmented shell, ash, fire-cracked rock, and roots. The fill in the features already referred to is mainly from this layer and the majority of the artifacts come from it. In the southern portion of the site Layer IIIa overlies portions of Layer II, and Layer IIIb overlies IIIa. Layer IIIa consists largely of whole shell with some lenses of sea-urchin spines, fragmented shell, fire-cracked rock, and so forth. Layer IIIb was the last to be deposited and consists of fragmented shell, rock, charcoal, and humus. Test Pit 1 shows one layer of highly fragmented shell, humus, rock, which on physical appearance probably relates to Layer II of the main excavation. The site thins out in this area and shell is only several inches thick in the northern portion of the test pit. Test Pit 2 has two layers, the lower of which is composed of a high shell content of whole and fragmented shell and probably relates to Layer I of the main excavation. Fragmented shell, ash, rock, and black dirt make up the level above it which probably corresponds to Layer II of the main excavation. It seems likely that the turf over the whole site should be set aside as a separate layer and cultural stratum as it is the only layer in which any trade goods were found. Two trade pipes and fragments of dark green bottle glass probably date from the English occupation or earlier. My suspicion is that excavation on the point itself, which is below the bank on which the excavated portion of the site rests, might reveal a component identifiable in part to the historic period and to which these trade goods might belong. A very shallow depression might prove to be the remains of a house.

A few features were uncovered. Six hearths and two fire pits were found. The hearths are best described as accumulations of fire-cracked rock with accompanying ash. The hearths tend to be oval in shape and vary from 5.5 to 1.0 feet in diameter. Two were inclusive within Layer I, three within Layer II, and one within Layer III. The fire pits are similar to the hearths, but differ in being contained in a shallow pit. They vary from 3.0 to 4.0 feet in width and from 0.7 to 0.8 feet in depth. Both were intruded from Layer II slightly into Layer I. A trench, 2.5 feet wide at the bottom and 4.75 feet wide at the top, had been intruded into the yellow subsoil in the northwestern part of the main excavation. It was filled with the whole shell of Layer Ib followed by Layer II. The excavated portion was 32 feet long and it continued into the unexcavated portion of the site. A small charred stump in the bottom of the trench was the only associated charcoal. A large pit had been excavated into the subsoil in the northeastern part of the excavation. It measured roughly 6 feet long and 5 feet deep and sloped to a rounded bottom. The fill of the pit consisted of a single layer of stones at the bottom. A very small

amount of charcoal was associated with these rocks. Above this was a layer of fragmented shell followed by a thin deposit of yellow silt, followed by a thick layer of whole shell. Its whole appearance suggests that it was constructed during Layer Ia times and possibly enlarged and reused during Ib. A mass of melted shell was uncovered in Test Pit 2 where it capped Layer I. The mass lay in black sand and shell and was surrounded by ash. Chemical analysis indicated that clam shells had been converted to the oxide form by the intense heat of a fir wood fire.

One complete burial was uncovered in Test Pit 2. The body had been placed on its right side, slightly on its back, with the head pointed to the south. The face had apparently been originally to the east, but as the body decomposed it fell over the right humerus facing down. The skeleton was fully flexed. There was no trace of a pit. Probably a shallow pit had been scooped out in the shell, the burial placed within, and a covering of the same shell put on top. The burial was apparently made during the deposition of Layer Ib. It was lying on a thin layer of mussel shell above the sterile soil and covered with shell mixed with black dirt. Above this and grading down into it is the silt and charcoal stratum which caps Layer Ib elsewhere in the site. Several fragments of human bone were found scattered throughout the site.

The following artifacts were uncovered. Their stratigraphic distribution and frequency are given in Table 1.

Barbed bone projectile points (Fig. 4 F, *o*) are not common. One fragmentary specimen with a pointed butt and oval cross section was uncovered. The place where the point is broken looks as if it has been partly reworked. Awls are common. The ulna awls are all made from deer ulnae. The tips are dull and slightly rounded. The splinter awls are simply bone splinters sharpened on one end. Bone chisels are all fragmentary specimens except one (Fig. 4 F, *i*)

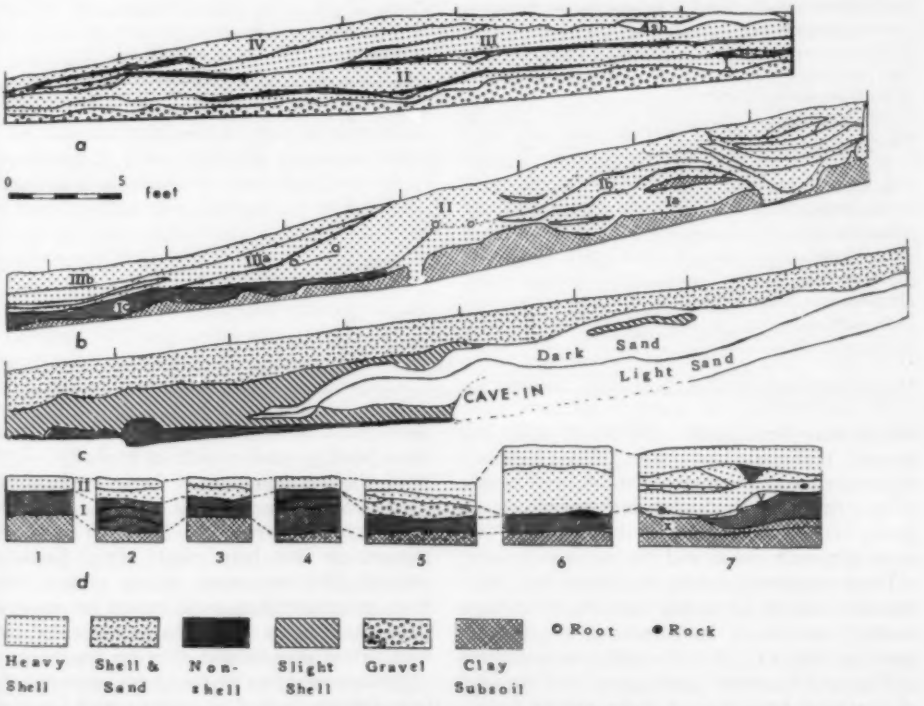

FIG. 3. Stratification at various sites. *a*, east wall of the main trench at Jekyll's Lagoon; *b*, west wall of main trench at Garrison; *c*, west wall of north-south trench at East Bluff of Cattle Point; *d*, north walls of Test Pits 1–7 at Argyle Lagoon: *x*, a layer of disturbed yellow clay which covered Burial 1; *y*, a lense of rotted wood fiber.

Table 1. Distribution of Artifacts in the Garrison Site.

Artifact type	Stratum I	II	III	Turf	Uncertain	Total
Barbed bone projectile points		1				1
Ulna awls	5	4	1		1	11
Bone splinter awls		3	3			6
Bone chisels		2	3			5
Bone needle	1					1
Bone ornaments						
Bird bone tube	1					1
Perforated pendant		1				1
Incised gaming bone fragment				1		1
Miscellaneous bone artifacts						
Elongate bone object fragments	1	5	2	1	1	10
Grooved cannon bone	1					1
One piece antler harpoons		3				3
Antler projectile points	1	1			1	3
Antler wedges		1	1			2
Antler flakers		6				6
Antler ornaments						
Perforated pendants		3				3
Grooved pendant		1				1
Anthropomorphic face		1				1
Miscellaneous antler artifacts	2	4				6
Adz blades		1			1	2
Ground stone points		2	5			7
Cobble hammerstones	2	4				6
Nipple-top maul			1			1
Whetstones and anvil stone	2	3	2			7
Stone ornaments		1				1
Chipped stone projectile points						
Triangular	2	6	2		2	12
Stemmed and barbed					1	1
Leaf-shaped		3	1			4
Side blades	3	2				5
Pentagonal		1				1
Fragments	3	1	7		1	12
Miscellaneous chipped stone		7	3			10
Shell artifacts		6			1	7
European goods				2		2
Totals	24	73	31	5	8	141

which may be a knife. All are of split and ground mammal long bone. One fragment shows a curved asymmetric bit. A bone needle (Fig. 4 B, *b*) has an asymmetric eye which appears to have been drilled biconically. The cross section is ovoid and the point is missing.

Bone ornaments consist of a bird-bone drinking tube or bead, 3.8 inches long, which has been ground smooth on both ends; a fragmentary pendant (Fig. 4 C, *b*) with a plano-convex cross section and biconical perforation; and the end of a gaming bone incised with a zigzag design. Miscellaneous bone artifacts consist of the distal portion of a deer cannon bone which had been grooved around the circumference and then broken, and which is probably detritis from the manufacture of bone artifacts; and fragments of elongate bone objects. These fragments are broader and thicker than their counterparts in San Juan phase sites. Some are pointed end fragments. Cross section varies from rectanguloid to ovoid except for one specimen which has a section like a truncated pyramid. They may be awl or point fragments.

One-piece antler harpoons are represented by two definite barbed specimens with tang and lateral lines guards (Fig. 4 F, *a*, *b*) and one problematical fragment with a line hole (Fig.

4 F, *e*). It is simply a guess that the latter specimen is a harpoon, but the curvature of the left side just below the break is so similar to that of the two harpoons that it may well be one. Antler projectile points which have no method of line attachment, and are consequently not harpoons, are represented by one unfinished unilaterally barbed specimen (Fig. 4 F, *f*); a short broad unbarbed point with a flat oval cross section (Fig. 4 F, *g*); and a triangular blunted point (Fig. 4 F, *p*) which may be a point for a blunt bird arrow.

Antler wedges are one key to the abundant wood working industry of historic times. One of the fragmentary specimens has a straight symmetric bit, and the other has a curved asymmetric bit. Antler flakers are made of deer antler, and in three instances the base of the antler is intact (Fig. 4 F, *m*). The tip of the flaker is grooved in one instance and blunt in the others. Three of the specimens are highly fragmentary and their classification as flaking implements is open to question.

Antler ornaments consist primarily of pendants. In addition, one triangular piece of antler is incised with an anthropomorphic face on one side of the piece only. Two of the perforated pendants are also incised and both appear to be reworked fragments of a larger object. Miscellaneous antler artifacts consist of three fragmentary objects: one large fragment which has been girdled as a preliminary to breaking; and two elongate objects one of which has a cut wedge-shaped base. Both of the latter may be unfinished points.

Adz blades consist of one unfinished specimen of nephrite and serpentine, and one unfinished fragmentary specimen of tufaceous argillite which has a round asymmetric bit. Ground stone points made of slate, schist, and obsidian were uncovered. The three slate specimens (Fig. 5 E, *f*, *j*, *k*) are thin (0.12 inch) and leaf-shaped with varied section. One is flat and diamond-shaped, one is hexagonal, and one is flat and oval. Two of the schist points (Fig. 5 E, *b*, *i*) are leaf-shaped. One has a hexagonal cross section and the other an oval cross section. The smaller specimen is very dull, possibly unfinished. A crude chipped piece of schist looks like a blank for another point. The obsidian point (Fig. 5 E, *e*) is relatively thick (0.21 inch) with a hexagonal cross section. It was first completely ground into shape and later rechipped on the edges. This was verified with a binocular microscope.

Cobble hammerstones are probably more common than the meager number found indicates. All show battering on one or more faces. One specimen has pecked finger depressions, two on each face. Another has a yellowish stain, possibly ocher. Nipple-top maul (Fig. 5 E, *h*) consists of the top portion only. These were used historically to drive wedges and stakes. Whetstones consist of small rectanguloid sandstone slabs. None show intentional shaping. A single specimen has striations suggesting use as an anvil stone. Stone ornaments consist of two incised mudstone concretions. One is ovate with crudely scratched lines on both sides which can be called decoration only in the very broadest sense of the word. The other has an anthropomorphic face nicely carved into both sides. The style is comparable to that found on seated human figurines holding bowls which are common along the lower Fraser River (Duff 1956).

Chipped stone projectile points are relatively common when compared with their distribution in San Juan phase sites. All are made of dense basalt and are somewhat asymmetrical and crude, particularly when compared with forms from the Plateau. They are neither small like the late forms over much of North America nor large like many of the "early man" points, but occupy an intermediate size range. Many of them are quite thick. Some of the crudity may be the result of the difficulty of working dense basalt. The following types are found: San Juan triangular (Fig. 5 C, *a–g*) is typically straight-sided and flat-based, though in actuality the sides vary from truly triangular to slightly incurvate to irregular, and the base from slightly concave to convex to irregular. Stems and barbs are absent. The most typical specimens come from the "Late" phase at Cattle Point (King 1950, Fig. 9, *25–31*). San Juan stemmed and barbed (Fig. 5 C, *n*) points are a fairly consistent though minor category. Only one specimen was found at this site although they occur in other assemblages. This type as a whole is fairly short and broad with a widely flaring barb on each side and a short contracting stem. The shape of the blade varies from triangular to concave to concavo-convex. Leaf-shaped points without stems do not form a consistent category and no named type is intended here. Two of the specimens have a corner notch on one side only (Fig. 5 C, *l*, *m*). The others are crudely leaf-shaped with convex bases (Fig. 5

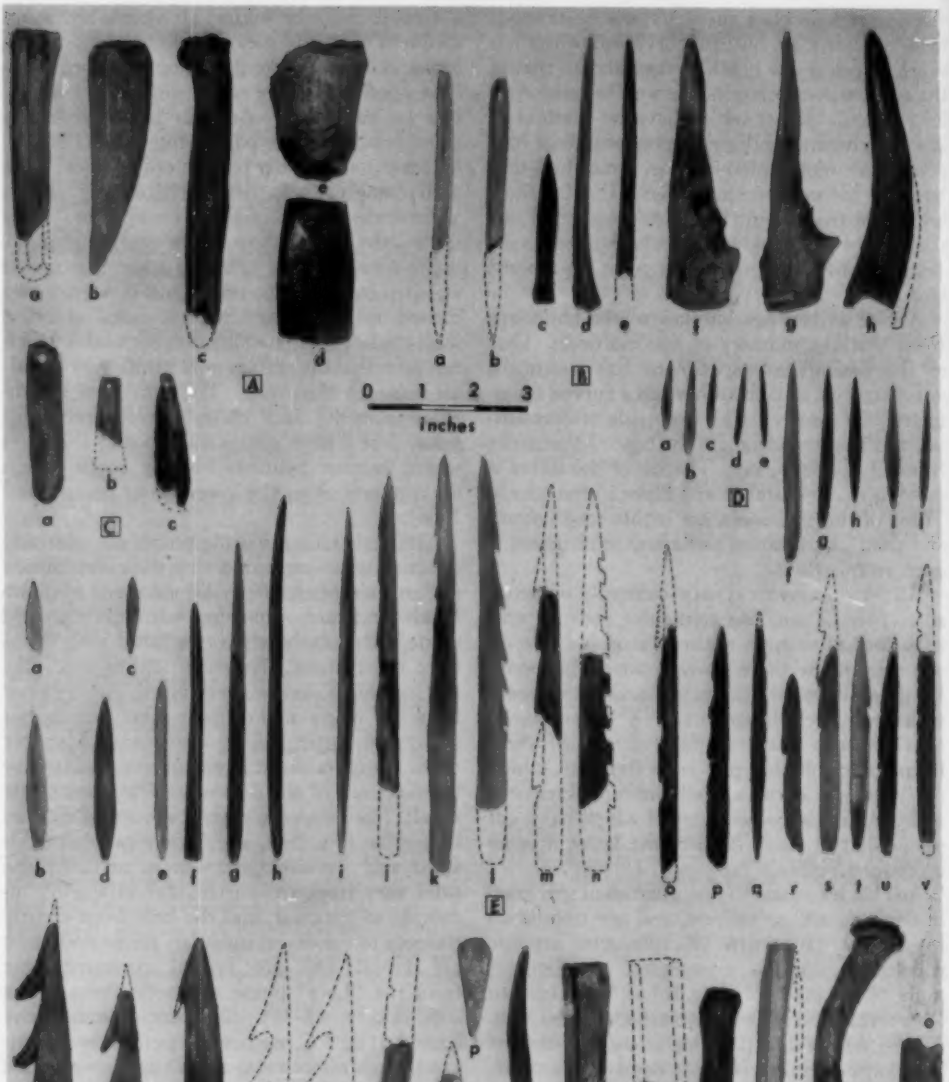

Fig. 4. Bone and antler artifacts. A, woodworking implements: *a*, bone chisel; *b*, antler wedge; *c*, bone knife; *d*, adz blade; *e*, antler haft for adz blade. B: *a*, *b*, bone needles; *c–g*, bone awls; *h*, antler object. C: pendants from Garrison. D, fishhook barbs from San Juan phase sites: *a–c*, bird-bone barbs; *d*, *e*, herring-rake barbs; *f*, *g*, halibut-hook barbs; *h–j*, salmon-hook barbs. E, bone projectile points from San Juan phase sites: *a*, *b*, flat toggle points; *c*, round

C, *j*, *k*) and could almost be grouped with the triangular points. Side blades (Fig. 5 C, *p-s*) were presumably hafted along the side of a wood or bone shaft. I do not know how else to explain the specimens with a leaf-triangular outline, although as yet no implements to which they could be hafted in this manner have been found. All are bifacially chipped and range from crude to well made forms. Pentagonal points (Fig. 5 C, *o*) are rare. Twelve point fragments which could not be classified were found. None of them show evidence of having possessed a stem.

Miscellaneous chipped stone artifacts consist of knives, scrapers, drills and a problematical graver. The knives (Fig. 5 C, *t*, *u*) are bifacially chipped. The five scrapers are simply small flakes of basalt with unifacial chipping to form a scraping edge. All are crude. The single drill (Fig. 5 C, *w*) has a thick ovate body which tapers to a narrow sharp tip on one end, and thins to an irregular edge on the other. Another specimen (Fig. 5 C, *v*) may be a drill or reamer.

Shell artifacts are very difficult to recognize in a shell midden. However, the following specimens were recovered: one end-perforated, ground *Olivella* bead from either Layer Ib or II; three *Dentalia* shells from Layer II; one nose ring of ground *Hinnites giganteus* from the turf; one clam shell grooved across the back possibly in the process of being made into an artifact; two clam shells with cut rectanguloid holes in the center; one perforated fragment of *Pectin caurinus* from Layer II; and one *Mytilus californianus* scraper from Layer II. In addition, 18 clam shells with holes broken through the center were uncovered in the excavation. However, it is questionable whether these can be classified as artifacts, for identical holes can be produced fortuitously by dropping the shells.

European goods were found only in the turf. The bowls of two clay trade pipes may date from the English occupation or earlier.

In summary, the excavation in this portion of the Garrison site showed the presence of three main occupational strata which do not differ markedly in artifactual content although some mixing must have occurred particularly during construction of features. The main occupation was during the deposition of Stratum II. The emphasis on stone chipping and the barbed harpoons with line guards indicate relationship with the Marpole site. The thin ground stone points which occur primarily in Stratum III are possibly prototypes for similar points at Cattle Point.

Richardson

Richardson (SJ–185) is the remnant of a large, disturbed, eroded shell midden located on a small bay just to the north of Mackaye Harbor on the southwestern side of Lopez Island. The highest portion of the midden is at present exposed right at the beach where a 4 to 5 foot vertical exposure runs for approximately 100 yards along the beach. One trench 5 feet wide and 25 feet long was excavated about 15 feet from the beach. About 500 yards to the south a 5 foot square test pit was excavated into the top of a high bluff overlooking the bay. The stratification of the main trench consisted of a lower, thin (up to 0.5-foot thick) layer of black dirt mixed with broken shell, rock, and cultural detritus; followed by a layer of mainly whole shell encompassing a large fired area which extended approximately half the length of the trench and varied from 0.5 to 2.5 feet in thickness; followed by the plow zone which varied from 1 to 1.5 feet in thickness and contained an admixture of nails, glass fragments, and so forth. A small pit with associated shell and sea-urchin remains partially capped by a layer of white clay and two rocks had been partially obliterated by the plow. A disarticulated human femur was encountered lying horizontally on the lower layer; 5 feet to the south a human skull surrounded by fractured deer bones, shell, and rock was found partially embedded in the yellow clay subsoil. The stratification in the test pit showed four layers which it is not possible to correlate with those in the trench. The following artifacts were recovered

toggle point; *d–h*, unbarbed arrowpoints; *i–n*, barbed spearpoints; *o–v*, barbed arrowpoints. F, artifacts from early sites: *a–d*, barbed antler harpoons with tang and lateral line guards; *e*, problematical harpoon fragment with line hole; *f*, unfinished antler projectile point; *g*, small unbarbed antler point; *h*, ulna awl; *i*, *j*, bone chisels; *k*, bone wedge; *l*, bone knife(?); *m*, antler flaker; *n*, bone haft(?); *o*, small barbed bone point fragment; *p*, antler point for bird bunt (?). Provenience: Cattle Point, Old Beach — A, *a*; B, *d*; D, *b*; E, *g*; Cattle Point, East Bluff — B, *g*; Argyle Lagoon — B, *a*; F, *d*, *h*, *j*; Jekyll's Lagoon — A, *c*; B, *c*; D, *a*, *c-e*, *j*; E, *h*, *m–s*, *u*, *v*; Turn Point — A, *b*; Garrison — B, *b*; C, *a–c*; F, *a–c*, *e–g*, *i*, *m*, *o*, *p*; Lime Kiln — B, *h*; D, *f*; E, *c*, *i-l*; Richardson — E, *e*; F, *k*, *l*, *n*; Mackaye — A, *e*; B, *e*, *f*; D, *g*; E, *b*, *f*; Moore — A, *d*; D, *h*, *i*; E, *a*.

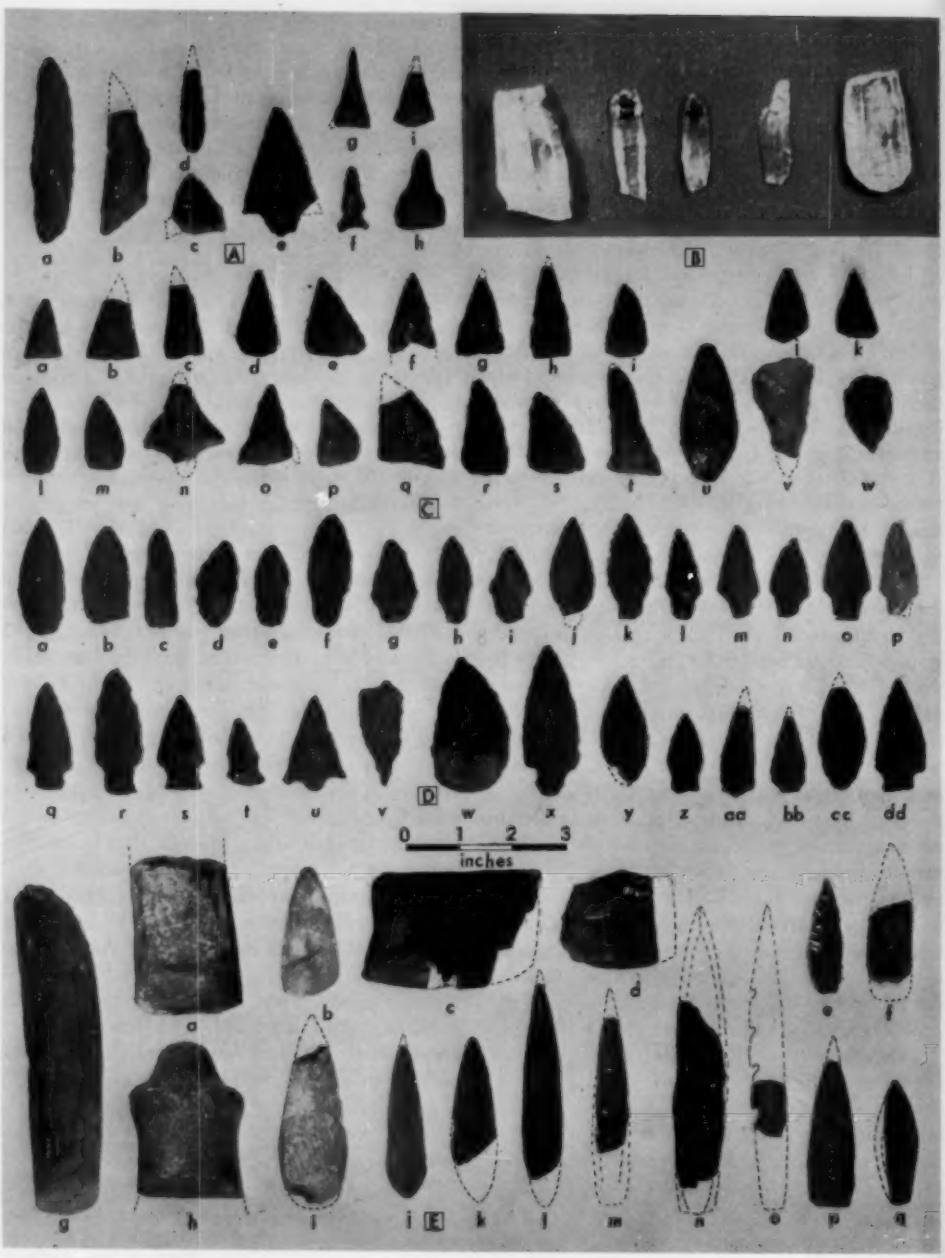

Fig. 5. Stone artifacts. A, chipped stone artifacts from San Juan phase sites: *a–c*, *e*, undoubtedly intrusives; *a–d*, Moore; *e*, Lime Kiln; *f–i*, Old Beach of Cattle Point. B: cores and microblades of quartz crystal from the East Bluff of Cattle Point, actual size. C, chipped stone artifacts from Garrison: *a–h*, San Juan triangular projectile points; *i–k*, leaf-shaped points; *l*, *m*, leaf-shaped points with single corner notch; *n*, San Juan stemmed and barbed point; *o*, pentagonal point; *p–s*, side blades; *t*, *u*, knives; *v*, *w*, drills. D, chipped stone artifacts from Argyle Lagoon (*a–w*), East

from the main trench: one slate knife ground on the curved cutting edge (Fig. 5 E, *c*); one fragmentary bone wedge and one fragmentary bone chisel; one ulna and two splinter awls; one antler wedge fragment; one perforated clam shell; one rib with a ground, wedge-shaped tip; two unstemmed, leaf-shaped points and one expanding-stemmed, leaf-shaped chipped basalt point (Fig. 5 D, *bb-dd*); and one small quartz crystal fragment. The following artifacts were found eroding from the edge of the site: one barbed antler harpoon with tang and lateral line guards (Fig. 4 F, *b*); and three fragmentary bone and antler objects. The test pit yielded: one bone knife or chisel fragment; two antler-wedge fragments; one halibut-hook barb; one fragmentary antler haft; one possible bone haft; one bird-bone awl with a needle-like tip; one cobble hammerstone; two fragments of what are probably unbarbed bone points; one elongate antler fragment; and one small soapstone fragment which resembles objects from what Duff (1956 Pl. 21) calls the Gulf Island complex. The Aldrich collection which is reported to have come mainly from this site contains several fragmentary ground slate points, some stone discoidals, and a piece of sculptured stone which looks like a rather broad maul with a sculptured bird head for a handle.

Additional excavation at the site was not recommended because of its disturbed nature. The site is difficult to generalize about. I doubt if the artifact assemblage represents a single component. However, several artifacts — the barbed antler harpoon, the sculptured stone maul, and the chipped points — show relationships with Marpole and indicate that at least part of the site should be placed in the Marpole phase.

OTHER EARLY SITES

Two sites which contain early components, but which are difficult to relate clearly to other components, are Argyle Lagoon (SJ–2) and the East Bluff area of Cattle Point. Both contain assemblages which cannot be reproduced elsewhere and for this reason they will not be grouped into phases.

Argyle Lagoon

Argyle Lagoon (SJ–2) extends about 300 yards along the north side of Argyle Lagoon on the southeastern side of San Juan Island. The lagoon is surrounded on two sides by a spit in the form of a V and on the third side (north) by a hill formed by a terminal moraine. The spit is formed from material eroded from the moraine (Wilson 1926: 137–9). The lagoon covers about 10 acres at high tide and about six at low tide. A narrow channel about 10 yards across connects the lagoon with the waters of the sound. The northern shore slopes up gently from the beach for several hundred feet, and then slopes upward rather sharply. The bank separating the gravel beach from the shore ranges from 4 to 7 feet in height. An underground spring is located near the center of the site in the area of modern occupation, and at least one other spring is found on the hill behind the site. There is no historic or ethnographic information concerning use of the site, although Harlan I. Smith (1907: 383) mentions what is apparently this site. Excavation was carried on in the eastern and western extremities of the site as the central portion is occupied by the houses of the owners. Portions of the site have been under cultivation for the past 60 years. Seven test pits running in a west to east direction were sunk into the midden. Test Pits 1–4 were 50 feet apart, approximately 50 feet from the bank at the edge of the beach, and 3 feet square; Test Pit 5 was 100 feet east of Test Pit 4 at the same distance from the beach, and was 5 feet square; Test Pit 6 was 350 feet farther east, 15 feet from the shore, and 5 feet square; Test Pit 7 was 40 feet farther east, 15 feet from the bank, and 7 by 8 feet in size.

The stratification (Fig. 3 *d*) in all seven pits showed two major culture-bearing strata. Stratum I is a dark, organic, clay-like soil lying immediately over the yellow clay or gravel subsoil. It contains no shellfish remains and varies from 1 to 2 feet in thickness. Stratum II differs from Stratum I in containing quantities of whole and fragmented shell in addition to black dirt, fire-

Bluff of Cattle Point (*x–aa*), and Richardson (*bb–dd*): *a–e*, *y*, *aa–cc*, simple leaf-shaped points; *f–t*, Argyle Lagoon stemmed points; *u*, San Juan stemmed and barbed point; *v*, drill; *w*, knife; *dd*, point or knife. E, ground and polished artifacts: *a*, *g*, adz blades; *b*, *i*, schist points; *c*, *d*, slate knives; *e*, ground and rechipped obsidian point; *f*, *j*, *k*, *p*, thin slate points; *h*, top of hand maul; *l–n*, *q*, thick slate points; *o*, barbed bone lance or spearpoint. Provenience — *b*, *e*, *f*, *h–k*, Garrison; *l–o*, *q*, East Bluff of Cattle Point; *g*, *p*, Old Beach of Cattle Point; *c*, Richardson; *a*, *d*, Turn Point.

cracked rock and so forth. It varied from 0.5 to 3.5 feet in thickness. Artifacts and cultural detritus were found from the top of the subsoil to the surface. The upper portion of Stratum II had been plowed so that the shell was very fragmentary and mixed with an occasional modern intrusion. The undisturbed portion contained areas of almost solid whole shell. Some layering is present in Stratum I, but I am not sure what it means. A layer of gravel separated the two major strata in Test Pit 5. Quantities of fish and mammal bone were found in both strata.

Shallow fire pits were found in Test Pits 4 and 6. In Test Pit 4 the fire pit consisted of a semicircular formation of fire-cracked rock at the edge of a small pit filled with sand, charcoal, and bone fragments. The pit was 8 inches deep and 18 inches wide. It was completely within Stratum I. Another more or less circular stone formation with a diameter of 1.9 feet and a fill of mammal bone and charcoal was in Stratum II in Test Pit 6. Fire-cracked rock occurred in all strata.

Two burials were encountered in Test Pit 7. Burial 1 was intruded into the yellow clay subsoil in a shallow pit, about 1 foot below the surface of the yellow clay. The skeleton lay on the left side in a semiflexed position with the right arm extending over and across the pelvis. The skull pointed to the west and faced north. The skeleton was covered with yellow clay except for the knees which were covered with dark dirt containing shell. The borrow material from the burial pit was deposited prior to the build-up of Stratum II. The skull of Burial 2 lay 1 foot to the southwest of Burial 1 and was 8 inches above it. The skull, right scapula, right humerus, right radius, right ulna, and right hand bones were all that were found of Burial 2. The lower arm bones were charred and there was evidence of a fired area directly above what would have been the pelvic region. The skull pointed north and faced west. Burial 2 had been placed in a 4-inch excavation in the subsoil and was covered with the dark soil of Stratum I. No grave goods were found wtih either skeleton. Both skulls were extremely long-headed.

The distribution and frequency of the various artifact types from Argyle Lagoon are shown in Table 2. The artifacts from the East Bluff area of the Cattle Point site are also shown on the same table, but are discussed separately in the section devoted to that site.

Chipped stone projectile points are the most numerous type of artifact from this site. The following types were found: Argyle Lagoon stemmed (Fig. 5 D, *f-t*) points have a convex-sided blade, usually sloping shoulders, and are always unbarbed. In four specimens true shoulders are lacking. The stem may be either contracting, expanding, or straight. I consider the types shown by King (1950, Fig. 9, *10–16*) to be of this generalized type. All are chipped from dense basalt with the exception of one (Fig. 5 D, *p*) which is made of yellow chalcedony. Another (Fig. 5 D, *f*) is heavily patinated probably from beach rolling although it was found in situ in the site. San Juan stemmed and barbed points, leaf-shaped points, and the drill conform to the descriptions given previously for the Garrison site. The leaf-shaped knife (Fig. 5 D, *w*) is well made. The flake knives are simply basalt flakes with cutting edges and the flake scrapers are simple flakes with scraping edges. One of the latter is made of chalcedony, the other of basalt.

The lamellar microblades and polyhedral core are of different materials. The core is a quartz crystal from which four blades have been removed leaving four long flake scars. Both blades are fragmentary and are made of obsidian. See the discussion of these implements in the Cattle Point section which follows.

Bone awls conform to the previous descriptions. The bone needle has an elongate eye sawed or ground (not drilled) from both sides, a rectanguloid section, and a broken point. The bone chisels are fragmentary. One (Fig. 4 F, *j*) has a curved asymmetric bit.

The tooth pendants consist of one small incisor from the plow-disturbed portion of Stratum II, which is perforated for suspension, and a canine with surface grinding which shows no means of attachment other than the natural constriction near the root.

The antler harpoon basal fragment (Fig. 4 F, *d*) differs from the typical antler harpoons with tang and lateral-line guards, but may tentatively be placed in this category. The antler haft is made of a forked deer-antler tine slotted at one end for what was probably a stemmed and shouldered knife. The slot itself forms the mouth of a face behind which is incised an eye. A series of incised wavy lines runs out from the eye. One of the forked ends is very blunt and could have served as a flaker.

Ground slate points are represented at this site by one medial fragment of a thin point which came from the plow-disturbed portion of Stratum II. The cross section is a flattened oval.

Two local collections include artifacts which were reported to have come from this site. The Anderson collection contains four large, ground slate, projectile points with hexagonal cross sections; one chipped stone point of milky quartz; one barbed bone or antler projectile point; and one perforated net sinker. These were reported to have come from the general area of Test Pit 5 from near the surface. The Taylor collection contains two stemmed and barbed chipped stone points; two hand mauls; two adz blades; two chipped stone knives; two large ground stone points; one grooved canine pendant; one end perforated canoe anchor; one perforated net sinker; one barbed bone or antler point; and one crude stone bowl. It is uncertain whether all of these artifacts come from this site.

This site is somewhat remarkable in containing a thick culture-bearing stratum resting on glacial subsoil in which no shellfish remains were found. Correlated with its location on a lagoon with abundant shellfish beds, this is even more remarkable. The absence of shell in a coast midden could be the result of one of several factors: (1) the utilization of shellfish was not part of the culture pattern of the group which occupied the site; (2) shellfish did not exist in adjacent waters at the time the cultural complex was deposited; (3) shellfish were utilized, but shucked elsewhere. A more extended excavation of this site might produce a definite answer to one of these suggestions.

The present limited excavation does not indicate major stratigraphic differences in artifact types. The large number of chipped stone projectile points and the quantities of land mammal bone (Table 4) point to a landward orientation of the culture, although it must be kept in mind that the cultural setting is on an island. The Argyle Lagoon stemmed points are most common in the "Island," "Maritime," and "Developmental" phases at Cattle Point and are absent in the "Late" phase. Lamellar microblades are also found in this context and the Argyle Lagoon finds relate most favorably there. It must be remembered also, that no shellfish remains were found in "Island" phase strata.

The component from Argyle Lagoon suggests certain similarities with the Marpole phase, but also certain differences. The main similarities are the great frequency of chipped stone points and the occurrence of a problematical Marpole type harpoon in the upper stratum. The stemmed projectile points from Argyle Lagoon, however, are so different from those from Garrison, which is certainly Marpole phase, that it is impossible at present to place the two sites in the same phase. Possibly when the projectile points from the Marpole site itself are described in detail more evidence of relationship will be seen. Bryan (1957: 8) suggests that there is a relationship between the Deception Pass phase in the Skagit-Whidbey area to the south of the San Juans and the Argyle Lagoon I component. The Deception Pass phase itself has leaf- and triangular-shaped points of basalt, cobble choppers, and a paucity of bone tools associated with an almost complete lack of shellfish remains in 2 feet of cultural deposit, but is unfortunately known from only a very small sample. There is also the possibility of relationship with the Whalen II phase (Borden 1950: 20) which numbers lamellar blades among its common elements and which has a radiocarbon date of A.D. 377 (Daugherty 1958: 454). If the lack of shellfish remains in Argyle Lagoon I is taken as indicative of a non-shellfish using culture, then this phase must be viewed as developmentally and chronologically earlier than this radiocarbon date, but with a continuity into Argyle Lagoon II (and Whalen II ?). Only additional excavation can clarify the situation.

Cattle Point

Cattle Point (SJ–1) is located on the edge of a natural prairie on the southwest shore of San Juan Island. King (1950) who directed extensive excavations at the site during 1946–47 divided the site into three distinct areas: (A) West Bluff, (B) East Bluff, and (C) Old Beach. The excavations described here were undertaken the following year and concentrated on the Old Beach and the East Bluff areas. The Old Beach excavation yielded a component identifiable with the San Juan phase and is described in a later section. The component from the East Bluff is earlier and is described here. The 1948 excavation in the East Bluff area lay between three sections of King's dig, and immediately to the east of the trench containing the stone alignment (King 1950: 64–5). The main trenches bisected each other, one running north-south and the other east-west. In addition, a

diagonal trench was run in a northeast-southwest direction for the purpose of continuing excavation of the stone alignment discovered the preceding season.

For the most part the stratification consisted of a single cultural stratum varying from less than 1 to about 4 feet in thickness. This stratum consisted of a heavy, black, sandy humus with scattered shell for the most part, but with occasional lenses of concentrated shell (Fig. 3 c). Occasionally this stratum became intensely black and contained only the smallest specks of shell. This was particularly noted in the case of the fill surrounding the stone alignment. It does not appear to represent a distinct cultural deposit. Below the cultural stratum lay a deposit of stained sand which graded from dark brown to light brown and yellow about a foot below the cultural layer. Lenses of this stained sand are also found within the cultural stratum. In the southern portion of the north-south trench the cultural layer thickens and is divisible into a stratum of sand and shell and one of little shell that comes to rest on a dense, black, compacted material which probably corresponds to the "Old Humus" stratum defined by King (1950: 64–5). The stone alignment rests on this level. This "Old Humus" was followed for about 13 feet north and presumably continued, but could not be checked because of caving sand walls. No artifacts were found either in the "Old Humus" or resting directly upon it. Seven possible post holes were encountered in the excavation. Four were in line about 1 foot apart; the others were scattered. The four were associated with the "Old Humus" which suggests that this layer may be a house floor and not old humus at all. Three shallow fire pits surrounded by rocks were found inclusive in the cultural stratum in the east-west trench. The portions of the stone alignment and the clay and rock bowls uncovered that season have already been discussed by King (1950: 64–74).

The distribution of the artifacts from the East Bluff of Cattle Point is given in Table 2. Awls and bone chisels do not differ from previously discussed specimens and need no additional comment here. Chipped stone projectile points (Fig. 5 D, *x-aa*) are all made of basalt. The stemmed points are provisionally classed as Argyle Lagoon stemmed.

Lamellar microblades and polyhedral cores were found in fair quantity. Three quartz-crystal cores, seven quartz-crystal microblades, and two obsidain blades were found (Fig. 5 B). Four blades had been removed from each of two cores, and one blade from the third. King (1950: 29) did not distinguish this type of artifact in his analysis of the Cattle Point material, and some of the microblades and cores from his excavation are discussed as worked quartz crystals. A check through his level bags brought to light additional blades and cores. These were distributed as follows: two obsidian blades from the "Island" strata and two from the "Maritime" strata of the West Bluff area; one obsidian blade from "Developmental" strata of the East Bluff area and one from the Old Beach; two microblades of quartz crystal, eight fluted quartz-crystal cores, and one problematical obsidian core fragment from the East Bluff area. Quartz-crystal fragments which are neither fluted cores nor lamellar microblades were distributed as follows: ten from the West Bluff area, one from the Old Beach, and eight from the East Bluff area.

The barbed bone spear point (Fig. 5 E, *o*) is fragmentary, but shows a small, enclosed barb. It appears to be made of sea mammal bone, but this is difficult to tell for sure as it is charred. The bone needles have a rectanguloid section, but lack the points. In one case the eye is cut or sawed in from both sides; the other is broken through the perforation. The bone wedge is made from a piece of long bone and must have been fashioned in the following manner: the bone was broken or sawed transversely and then one of the resulting halves was sawed and split longitudinally through the epiphysis; the epiphysis was ground on the top and on the sides to form the striking platform, and the other end was ground and sharpened to form the bit. Most of the bit is broken off. The bone knife is of split long bone and is identical to one shown by King (1950, Fig. 14, 9). Miscellaneous bone objects include three worked bone fragments, a bird bone with a beveled end, the tip of a flat pointed object, and a fragment of an elongate bone object with rectanguloid section.

The ground slate points (Fig. 5 E, *l-n*, *q*) are all thick (0.17 to 0.35 inch) with covex sides. Three have a hexagonal and one an oval section. One has a base noticeably thinned for hafting. Perforated net sinkers were made from small cobbles. All are fragmentary and five are unfinished, suggesting that they were broken in the

TABLE 2. DISTRIBUTION OF ARTIFACTS AT ARGYLE LAGOON AND THE EAST BLUFF OF CATTLE POINT.

Artifact type	Argyle Lagoon			Cattle Point East Bluff
	Stratum I	Stratum II	Total	
Chipped stone				
Projectile points				
Argyle Lagoon stemmed				
Expanding stems	3	1*	4	2
Contracting or straight stems	2	9	11	
San Juan stemmed and barbed	1		1	
Leaf-shaped	4	2*	6	2
Unclassifiable fragments	1	1	2	2
Drill		1	1	
Leaf-shaped knife		1	1	
Flake knives		5	5	
Flake scrapers		2	2	
Microblades		2	2	9
Polyhedral core		1	1	2
Barbed bone spearpoint				1
Ulna awls	2	9	11	2
Bone splinter awls	1	1	2	2
Bone needle		1	1	2
Bone chisels		2	2	2
Tooth pendants		2	2	2
Bone wedge				1
Bone knife				1
Miscellaneous bone objects	1		1	6
Ground slate points		1	1	4
Cobble hammerstones	2	2	4	
Anvil stone	1		1	
Perforated net sinkers				7
Whetstones				7
Miscellaneous ground stone				8
Antler gouge				1
Antler harpoon fragment		1	1	
Incised antler haft		1	1	
Mytilus californianus shell artifact				1
Total	18	45	63	64

* Stratigraphic placement uncertain.

process of manufacture. The perforations are central, pecked, and biconical. Whetstones are small, irregular pieces of sandstone. These were undoubtedly used for shaping artifacts as well as sharpening them. Miscellaneous ground stone consists of the following specimens: one schist fragment; one slate fragment; one thick rectanguloid slate blank; one small ovoid pebble abraded on both sides; one shale fragment incised with a zigzag design; one small flake of obsidian ground on the edge; a tip of a stone club which was found on the surface; and one ovoid beach cobble stained red.

The antler gouge closely resembles a miniature wedge and has a rounded asymmetrically beveled bit. It is made from the tine of a deer antler. *Mytilus californianus* shell artifacts consist of one fragmentary specimen that has had the hinge removed and the edges ground flat so that it resembles the poll of an adz blade. The bit is broken off. This assemblage from the East Bluff area is startlingly different from that to be discussed for the Old Beach. Four types of artifacts stand out: perforated net sinkers, lamellar microblades and cores, whetstones, and long thick ground slate points. Stratigraphically, the sandy humus from which these artifacts come would fall into both King's "Maritime" and "Developmental" phases. The few artifacts found were distributed in all parts of the excavation and the distribution suggests that all the major types are culturally and temporally related.

However, the general appearance of the area suggests that this is the periphery of the site, and that we are dealing with sporadic occupation. A check on the distribution of these main artifact types with the use of King's field notes shows that the lamellar microblades and cores, the long heavy ground slate points, and the perforated sinkers were all concentrated in the East Bluff area. Of the 14 long, leaf-shaped, ground slate points figured by King (1950, Fig. 11, *6–10*) two come from the "Island" phase of the West Bluff area and eleven from the "Developmental" and "Maritime" phases of the East Bluff area. The fourteenth point of this type was placed in the "Developmental" phase, but came from a level which included upper "Island" and lower "Developmental" strata in the West Bluff area. Of the 63 perforated (complete or incomplete) net sinkers and canoe anchors, 43 came from the East Bluff area, 14 from the West Bluff area, and six from the Old Beach. The distribution of microblades and cores has already been mentioned. Possibly there were greater horizontal than vertical differences between the East and West Bluff areas.

San Juan Phase Sites

The following sites contain components belonging to the San Juan phase: Jekyll's Lagoon (SJ–3), Turn Point (SJ–4), Lime Kiln (SJ–99), Moore (SJ–5), Mackaye (SJ–186), and Cattle Point (SJ–1).

Jekyll's Lagoon

Jekyll's Lagoon is a small shellmound located on the northeast shore of Jekyll's Lagoon, a small indentation on the southeastern shore of San Juan Island. The lagoon is almost enclosed by a long gravel spit which has a narrow opening at its western end. Floral cover is limited to weeds and thistle on the site itself, although excellent stands of fir and cedar cover the slopes surrounding the lagoon. Shellfish are found in the flats and bars of the lagoon. The site is on the approximate boundary between Samish and Lummi territory, but there is no ethnohistorical information concerning its use. Shell deposits occur on both sides of the narrow entrance to the lagoon, and on a small peninsula which juts out into the lagoon from the eastern shore. The northeastern shell deposits, located at the junction of the spit and the shore, appeared to contain the deepest deposits and were tested with one trench, 40 by 5 feet, and seven test pits. The test pits were situated in order to sample the structure of the mound and to determine the actual extent of the cultural deposit. The culture-bearing strata averaged about 2.5 feet in depth and varied from 1 to 3.5 feet.

The stratigraphy is basically similar throughout the site and consists of layers of predominantly whole shell separated by layers of beach gravel. Four culture-bearing strata were found in the main trench (Fig. 3 *a*) and in Test Pits 1, 2, and 7, although no artifacts were obtained from the lowest stratum except in Test Pit 2. Stratum I immediately above the sterile beach gravel consists of a black dirt matrix containing pulverized and partly decomposed shell compacted into a dense, almost homogeneous mass. *Mytilus edulis* is the dominant shell. Charcoal and animal bone were found in limited quantities. A thin, brown-black matrix of clay, gravel, and sand separates Stratum I from Stratum II, which consists of a gray-black matrix of dirt containing large amounts of densely compacted whole shell. Mammal and fish bones are few and widely distributed. A thin layer of gravel in a gray-black and occasionally yellow sand matrix with occasional shell intrusions separates Strata II and III. Stratum III consists of a gray-black dirt containing great amounts of densely compacted whole shell and a moderate amount of mammal and fish bone. In the seaward portion of the trench and in Test Pits 1, 2, and 7 a thin layer of gravel separates Strata III and IV. Stratum IV consists of a loose, gray-black matrix of dirt and well fragmented shell which grades into a thin humus cover. Test Pits 3 and 4 had only one layer of humus and loose shell above sterile beach gravel. Test Pit 6 contained no artifacts and showed a layer of dense shell containing large fragments of charcoal and burned sand over beach gravels. Test Pit 5 produced two shell layers separated by a gravel layer. The only artifacts came from the upper shell layer.

Habitation features were few and poorly defined. A small pit intruded from Stratum IV into Stratum III in Test Pit 1. It measured 1.5 feet across the top and sloped to a rounded bottom about 0.5 feet across. A large ash accumulation was found in the upper end of the main trench in Stratum IV.

The site suggests essentially four and possibly five periods of occupation with no apparent culture change between them. Plotting the artifacts failed to reveal any significant distribu-

tional differences. The gravel layers which were sterile of artifacts are probably the result of storms and high tides during the winter months. Most of the artifacts, which are discussed in a later section, are associated with hunting and fishing activities. Only a few are related to manufacturing activities which suggests that the site was probably a temporary camp occupied primarily in summer. The absence of heavy humus cover and of forest cover, as well as the artifact assemblage, are indicative of the recency of the occupation.

Turn Point

Turn Point (SJ–4) is the badly eroded remnant of a large shell midden located in a small bay off Turn Point on the eastern side of San Juan Island. Shell is exposed in a 50-foot exposure on the mainland and in a 25-foot exposure on a small island connected by a gravel bar. The beach is good and the area is protected from winds. The site probably once extended across the gravel bar and has been subsequently washed away. There is no ethnographic information concerning use of the site.

A single 5-foot square test pit was sunk into the midden. The depth of the deposit is 3 feet and consists of 14 thin, loose, layers of whole and fragmented shell, urchin, ash, and fish and mammal bone. A large whale scapula was found in association with several large rocks and ash in the upper foot. The artifact yield was not significant but along with the physical stratigraphy indicates that the site is late. Further excavation was not recommended.

Lime Kiln

Lime Kiln (SJ–99) is located on the west coast of San Juan Island. It is a shell deposit located on a 25 degree slope area on a rocky bluff overlooking Haro Strait. Outcroppings of rock occur all over the slope and the deposit is thin and scattered. The cliff is approximately 25 feet above the water, but the beach could have been reached by what appears to be a natural stairway in the rock wall. The site was chosen for testing as it is one of the few sites on the rocky coast of the island and because the surface finds were promising. Four test pits were sunk into the site and exposed a cultural layer consisting of shell, ash, and humus overlying sterile yellow clay. The deposit averaged 1.5 feet in depth. Three small posts with diameters of about 0.2 feet were found in a row extending into the subsoil. Two medium sized rocks were adjacent to the posts. The site suggests sporadic occupation and most of the artifacts belong to the San Juan phase. A large chipped basalt projectile point which was found at a depth of 15 inches undoubtedly is earlier.

Moore

Moore (SJ–5) is located in the garden plot of Vincent Moore on the shore of a small bay on the eastern side of San Juan Island. The site is on a bank from 1 to 7 feet above the present beach level. The relief of the property is a gentle slope to the south until it is intersected by a small seasonal stream. Springs exist in both the woods to the north of the site and to the south. Shell deposits extend from the stream north to the wooded area beyond the excavation. Shellfish occur in the bay, although it is not considered a particularly good clamming beach by the White residents. The site lies in Lummi territory and the owners stated that Lummi (?) Indians gathered moss in the woods just to the north of the site in 1945.

Five trenches of varying sizes (Fig. 6) were excavated into the midden. Stratigraphically the site is very simple. The over-all cultural deposit appears as one stratum and does not exceed a depth of 1.5 feet. The stratum consists of a deposit of humus, rock, shell, charcoal, and fish, mammal, and bird bones. The

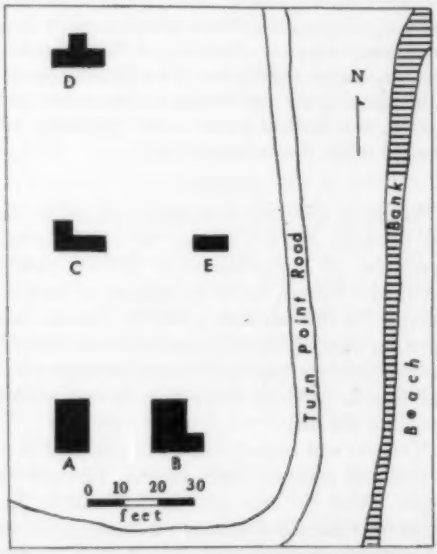

FIG. 6. Plan of excavated areas at Moore.

upper foot of the deposit has been plowed and the shell reduced to small fragments. Whole shell occurs below the plow zone in a few places. The subsoil consists of either the typical yellow clay which underlies most sites in this area or an orange clay containing an extensive amount of charcoal and burned vegetal matter. Both are sterile. The top of the subsoil is dotted with the root patterns of former trees containing partially burned and decayed wood. Shell intrudes into some of these holes. Habitation features consist of one fire pit, two hearths, and one small charred post. The small fire pit was intruded into the yellow clay. It is 1.3 feet long, 0.55 foot wide, and 0.50 foot deep, and is filled with small round cooking stones and charcoal. One hearth consists of a semicircle of rocks around a concentration of small rocks and charcoal and the other of a small mound of ash, charcoal, fire-cracked rock, and shell. A small charred post with a diameter of 0.3 foot extends into the sterile subsoil for 0.5 foot.

The lack of evidence of houses and the shallow deposit suggest that this too was only a camp site. The artifact assemblage while highly fragmented shows that the site belongs to the San Juan phase although two chipped basalt artifacts are probably intrusive from an earlier period. In addition to the artifacts found during excavation there were several which Moore had gathered during gardening: three thin, partially ground, fragments of slate which appear to be fragments of knives; two ground slate fragments with an abrupt double bevel on the edge suggest portions of points or blades for composite harpoons; one barbed bone point fragment; and several other fragmentary items.

Mackaye

Mackaye (SJ–186) is a shell midden located on Mackaye Harbor, a large bay on the southwest end of Lopez Island in historic Samish territory. Present cover is limited to grass although the site has been plowed. The site itself is in the form of a low mound which is partially obliterated by a road which cuts between it and the beach. Modern occupation has obliterated much of the site.

The site was tested with three test pits, 15 by 5 feet, and another 5 feet square. The test pits were 5 feet, 10 feet, and 25 feet apart. The main stratigraphic distinction is between a lower stratum of predominantly whole shell, and an upper plow-disturbed stratum of fragmented shell and black dirt. A thin, but dense, band of black sandy dirt separates the shell midden from the underlying yellow clay subsoil. The test pit nearest the beach was somewhat distinctive in containing a number of thin, discontinuous, horizontal lenses of sand which gave the profile a peculiar banded appearance. This may be the result of greater proximity to the beach and occasional high tides. Depth of the deposit varies from 1.4 to 3.75 feet.

Distinct habitation features were few and indefinite. Concentrations of rocks associated with burned shell, ash, and charcoal occurred in all test pits. In the north wall of Test Pit 2 the remains of what may be a post hole extend from the cultural stratum into the subsoil.

Cattle Point

The Old Beach at Cattle Point had been excavated by King (1950) and the reader is advised to check his report for a general description of the site. His work was supplemented by five test pits in the west and central portions of the Old Beach. On the eastern portion of the beach a T-shaped trench was excavated through the center of a low mound. King's datum (1950, Fig. 1) was used and the north-south trench ran from 83 to 133 feet north of the datum at 112 to 117 feet east of the datum the east-west trench joined it at 107 to 112 feet north, and ran from 117 to 137 feet east. The beach test pits were scattered and produced no significant features, only a single stratum of shell and organic debris resting on beach gravel. The beach mound, however, shows three strata of dark humic sand containing shell separated by layers of yellow beach sand. All of the artifacts came from the upper stratum with the exception of one fragment of chipped and ground slate which came from the lowest layer and two bone awls which came from either the upper or the middle stratum. The upper stratum is composed of thick, black, humic sand containing lenses of clam, mussel, and sea-urchin shell and varies from 1 to 1.5 feet in thickness. The other two strata are similar, but not so thick. A general view of the area suggests that the beach east of the datum point was once a lagoon which opened at the east end where the terrace comes to the water. The stratigraphy suggests that the mound was used seasonally and briefly at two periods before the lagoon was protected by the present gravel spit and log pile, and that the mound was washed over by high waters which

TABLE 3. DISTRIBUTION OF ARTIFACTS IN SAN JUAN PHASE SITES.

Artifact type	*Jekyll's Lagoon*	*Turn Point*	*Lime Kiln*	*Moore*	*Mackaye*	*Cattle Point*	*Total*
Barbed bone arrow points	13	1		4	1	1	20
Barbed bone spear points	2		5			1	8
Flat toggle points				1	1		2
Round toggle points			1			2	3
Unbarbed bone projectile points	1				1	5	7
Salmon-hook barbs	15		1	4	10	2	32
Halibut-hook barbs	1		1		2		4
Herring-rake barbs	2			1			3
Ulna awls	1	2	1	1	5	1	11
Bone splinter awls	2	1		2	7	4	16
Split mammal bone awls	3					4	7
Valves for toggle harpoon					2		2
Bone chisels	1			1	1	2	5
Miscellaneous worked bone	14	4		20	13	1	52
Antler wedges	2	1		1		1	5
Miscellaneous worked antler	1		1	2	4	1	9
Adz blades		1		1	1	1	4
Ground slate or schist points						4	4
Ground slate knives		1		5		1	7
Whetstones	1				1	1	3
Miscellaneous ground stone	2	1	1		3	2	9
Chipped stone artifacts	1		1	4		14	20
Ground *Mytilus californianus*	2				5	1	8
Miscellaneous worked shell		1				1	2
Ocher or pigment				1	1		2
European goods			1				1
Total	64	13	13	48	58	50	246

brought in layers of beach sand covering the occupation layers. The top layer suggests longer use after the spit was built high to protect the site from washing by the sea, and abandonment during or prior to the filling of the lagoon.

Artifacts from San Juan Phase Sites

The following artifact types were recovered from the sites just discussed. The distribution by site is given in Table 3. Fragmentary specimens are included in the analysis when their identification is reasonably certain.

Barbed bone arrow points (Fig. 4 E, *o-v*) consist of long, narrow, unilaterally barbed points with either a wedge-shaped or conical butt for insertion into the cleft end of a wooden shaft or foreshaft. The cross section varies from ovoid to rectanguloid. The barbs are frequently only simple notches and in no case do they flare widely from the body of the artifact. One specimen (Fig. 4 E, *o*) has an incised line running longitudinally down both sides near the barbed edge and horizontal lines incised into the top of the barbs. All specimens are of land mammal bone, probably deer or elk. Barbed bone spear points (Fig. 4 E, *i-n*) are large, wide, unilaterally barbed points which are either plano-convex in cross section thus permitting scarfing of the flat side against the wooden foreshaft of the large multiple pointed duck spear or with a base thinned for insertion into the foreshaft. The five specimens (Fig. 4 E, *i-l*) from the Lime Kiln site were found on the surface and were donated to the field party. One of them is represented by a base fragment only. I suspect they constitute the remains of a single artifact, a duck spear. One specimen (Fig. 4 E, *m*) has an incised line running down both sides near the barbs. It is doubtful if any of these points functioned as leister points because the historic leister type in this area used points made up of a single separate bone barb hafted to a foreshaft. All are made of land mammal bone.

Flat toggle points (Fig. 4 E, *a*, *b*) consist of small bone points with a thin, squared or rounded, wedge-shaped butt and a flat, rectanguloid cross section. They probably served as blades for the type of composite toggling harpoon with a flat blade bed. Round toggle points

(Fig. 4 E, *c*) consist of small bipointed bone points with a circular or ovoid cross section and an abrupt tip. They probably functioned as the point for the composite toggling harpoon with a rounded blade bed. Snyder (1956, Pl. 5) illustrates a small composite toggle head found armed with a point of this type. Unbarbed bone projectile points (Fig. 4 E, *d–h*) show several different forms. Of the seven specimens three have a rectanguloid cross section and a flat, ground butt (Fig. 4 E, *f-h*); one has an abrupt tip which rapidly thins to a wedge shaped butt (Fig. 4 E, *e*); one has the tip missing and the base thinned from one side for scarfing against a shaft; one is very short and has a diamond-shaped cross section (Fig. 4 E, *d*); and the last has a thick squared base which tapers to a rounded point.

Salmon-hook barbs consist of two types. Small bipointed bone barbs which show wear on one end only and which taper from a thick center are the only candidates for the salmon hook described in the literature (Fig. 4 D, *h-j*). In cross section the lower half on this barb is either rectanguloid or plano-convex with at least one flat side for scarfing against the shank of the hook. The point is circular in cross section and is slightly longer than the base. King (1950, Fig. 13 *10, 13*) illustrates this type. This same type of barb could have functioned as the barb for the historic leister. Thin, bipointed or rounded base bird-bone splinter barbs (Fig. 4 D, *a-c*) are also salmon-hook barbs. Identical specimens can be seen hafted to historic Tlingit salmon hooks (Washington State Museum catalogue numbers, 1886, 1326, 1329). The excavations yielded 25 of the first type and seven of the latter. Halibut-hook barbs (Fig. 4 D, *f, g*) are difficult to identify. On historic specimens the barb consists of a bipointed bone with a circular cross section hafted against the side of the U-shaped halibut hook. The specimens categorized here as halibut hooks conform to this pattern, but the butt portion of the barb is poorly worked. Herring-rake barbs (Fig. 4 D, *d, e*) are small, symmetric bone barbs with a circular cross section and a fairly abrupt wedge-shaped butt. Their historic counterparts are iron nails.

Ulna awls (Fig. 4 A, *f, g*) are one of the most numerous items found here archaeologically. All of the excavated specimens are made of deer ulnae. Distinguishing between ulna awls and ulna knives is difficult. None of them from the San Juans are actually sharp enough for slitting a fish as Drucker (1943: 52) suggests. The tip is usually dull and slightly rounded although one specimen (Fig. 4 B, *f*) has a screwdriver-shaped tip. They were undoubtedly multipurpose tools. Bone splinter awls are elongated and pointed bone objects which show shaping or wear only at the tip. Some may be unfinished barbs for composite fish hooks. Split mammal bone awls (Fig. 4 B, *c, d*) are distinguished from the preceding category by over-all working of the shaft. Five specimens have the epiphysis modified and the other two have it removed completely.

Composite toggling harpoon heads are made up of three pieces: two valves made of bone or antler, and a single point or blade made of bone, ground stone, or ground shell. The blade bed, meaning the portion of the valve designed to hold the blade, may be either flat for a blade which has a flattened cross section or round for a blade with a rounded cross section. The toggling or turning action is accomplished by attaching the harpoon line on the side of the harpoon head so that when the line is taut, the head automatically turns. Small toggle heads were used with salmon harpoons, larger ones with seal harpoons, and even larger ones with whale harpoons. Only two specimens were recovered from the excavations and these were unfinished. Possibly this is due to sampling error as more specimens were to be expected.

Bone chisels do not form a homogeneous class. The specimen from the Moore site is badly weathered, but suggests a chisel; the specimen from Jekyll's Lagoon (Fig. 4 A, *c*) more closely resembles a knife, but the bit is broken; both specimens from the Old Beach at Cattle Point are broken, but are of the same type (Fig. 4 A, *a*). One of them was re-used as an awl. This type is made of split long bone which has been ground so that the split side is flat, possibly for hafting as the historic D-adz is hafted.

Miscellaneous bone artifacts which are not conveniently categorized consist primarily of fragmentary specimens. The most common group is made up of fragments of elongate bone objects. These must be parts of awls, bone points, or fish hooks. They are distributed as follows: 14 from Jekyll's Lagoon, one from Turn Point, 16 from the Moore site of which five are wedge-shaped bases of bone points, nine from the Mackaye site, and one from the Old Beach at Cattle Point. Other specimens consist of an

obliquely beveled tip of what was probably a bird-bone needle, a polished mammalian rib, a large elk-scapula digging tool with the proximal end hacked off and the transverse spine ground down, and a curved pointed fragment which may be part of a blanket pin. These are all from Mackaye. Other objects include one polished tubular bird-bone object broken at both ends, another ground on one end and broken on the other, and six worked bone fragments.

Antler wedges (Fig. 4 A, *b*) were used in the wood working industry for making canoes, house planks, and so forth. Only two of the excavated specimens are complete. Both have a rounded bit and taper asymmetrically from the butt. Miscellaneous antler artifacts consist of the following: a tine with the tip hacked and smoothed and the proximal end broken; a polished, tapering curved tine with a triangular projection on side of the proximal end (Fig. 4 B, *h*); two fragments of elongate objects; a small rectanguloid piece of cut antler; a weathered tine with what appears to be a conical socket in the proximal end; a distal end of an antler which has been grooved three-fourths of the way around; and one haft (Fig. 4 A, *e*) formed from the proximal end of an elk antler. The haft was shaped by hacking and cutting rather than by grinding and polishing. Possibly it is incomplete. The field notes state that the small adz blade found at Mackaye fit the haft perfectly, but the specimen itself is missing. From Cattle Point came a fragment of a blunt rounded antler object.

Adz blades are represented by one fragmentary specimen, two complete specimens, and one missing specimen. The fragmentary specimen (Fig. 5 E, *a*) has a straight bit which is beveled both dorsally and ventrally. The saw marks where it had been sawed from the original stone remain. One of the complete specimens (Fig. 5 E, *g*) is very long and has a slightly curved bit. The bevel is predominantly from one side, and the saw marks are in evidence. The other complete specimen (Fig. 4 A, *d*) is small, highly polished so that the saw grooves no longer show, and has a slightly curved bit and a poll which tapers to a squared butt. The description and sketch of the missing Mackaye specimen indicate that it is of this latter type.

Ground slate or schist points (Fig. 5 E, *p*) are all thin (not more than 0.10 inch thick), leaf-shaped in outline, and beveled to a sharp cutting edge. The complete specimen has a straight thinned base, whereas one of the fragmentary ones has a suggestion of a notched base. Two specimens are made of slate, two of schist. Ground slate knives (Fig. 5 E, *d*) are thin and worked primarily on the curved cutting edge. All specimens are very fragmentary. Whetstones for grinding and sharpening bone and stone implements should be very common although only three specimens occur in San Juan phase sites. The one from Jekyll's Lagoon is a more or less oval piece of slate; the one from Cattle Point a rectangular piece of slate with uneven ends; and the one from Mackaye a square piece of sandstone. All show wear characteristic of use as whetstones.

Miscellaneous ground stone artifacts were found at all sites except Moore. Jekyll's Lagoon yielded a rectanguloid piece of slate with one edge worn smooth, but otherwise unmodified, and an unmodified slate fragment which suggests the back of a small slate knife. Turn Point produced a small cobble hammerstone. A small V-shaped sandstone cobble showing smoothing on two sides as if it had been used as a saw for cutting nephrite for adz blades was found at Lime Kiln. Two mudstone concretions decorated with crude scratched lines, which ran roughly diagonally across one specimen and ran at random on the other, and a small ovoid cobble with one end reduced slightly by pecking were found at Mackaye. From the Old Beach at Cattle Point came a fragment of ground and sawed stone, and a fragment of chipped and ground slate.

Chipped stone artifacts are few in number in San Juan phase sites. This is in accord with the ethnographic literature where numerous scholars (Boas 1916: 52; Kroeber 1923: 8; Olson 1936: 75; Drucker 1943: 122–4) have commented on the absence of stone chipping among historic Northwest Coast Indian groups. No chipped stone was found in the excavations at Jekyll's Lagoon, although one fragment of a bifacially chipped knife or point of basalt was found on the shore of the lagoon. One large basalt projectile point or knife (Fig. 5 A, *e*) was found at Lime Kiln at a depth of 15 inches near the subsoil. The Moore site yielded four chipped stone artifacts: one pentagonal point of opalite (Fig. 5 A, *c*) which is probably a trade piece from the Plateau; a small, leaf-shaped basalt point with serrated edges (Fig. 5 A, *d*); one long basalt point with an almost diamond-shaped cross section and which exhibits basal grinding (Fig. 5 A, *a*); and one large flake or blade. This

flake (Fig. 5 A, *b*) was found embedded in the top of the subsoil and along with the two preceding points undoubtedly belongs to an earlier manifestation.

The Old Beach at Cattle Point produced 13 chipped basalt artifacts and one unmodified chip of milky quartz. This amount is not commensurate with the small quantity found at other sites. They consist of the following specimens: one small triangular point with a concave base and side notches (Fig. 5 A, *f*); two small unnotched triangular points with straight and concave bases respectively (Fig. 5 A, *g*, *i*); one medial fragment of a small narrow projectile point; one pentagonal point, or viewed the other way, stemmed knife (Fig. 5 A, *h*); three fragments of projectile points or knives; three small crude flakes of basalt with scraping edges; one large, crude, percussion-chipped, basalt slab or club; and one basalt core. The presence of chipped stone and chipping detritus in limited quantities suggests that this site belongs to an early portion of the San Juan phase deposited as chipped stone was going into disuse. Actually, the late phase which King (1950) outlined for Cattle Point corresponds reasonably well to the San Juan phase outlined in this study if the great numbers of chipped stone points from the surface are separated from those actually uncovered in the late deposits. A review of King's field notes shows that only seven of the 29 projectile points from his late phase were actually excavated. The others came from the surface where weathering factors preclude the finding of bone implements. Thus the ratio of chipped stone to bone was not established. Future work may justify setting off the Old Beach at Cattle Point into a separate phase preceding that in which stone chipping is lacking entirely, although there was some utilization of the Old Beach in historic times; in going through the level bags from King's excavations, I discovered the stem of a white clay trade pipe and a small, sheet copper, triangular pendant in a bag of surface finds from the Old Beach.

Ground *Mytilus californianus* shell artifacts are all fragmentary specimens of either knives or scrapers. There were no fragments of either projectile points or adz blades. Miscellaneous worked shell artifacts consist of a small perforated clam shell from Turn Point and a clam shell with a rectanguloid cut notch opposite the hinge from Cattle Point.

Ocher or pigment was found at two sites. At Moore two lumps of a pink chalky substance could have been used for pigment. A clam shell filled with pulverized red ocher was uncovered at Mackaye.

European goods were found only at Lime Kiln. A circular brass object with a central perforation around which are small incised lines or "ticking" was found two inches below the surface.

In summary, the artifacts which are common and typical of the San Juan phase sites discussed here are bone fish hook barbs, barbed bone projectile points, bone awls, and miscellaneous worked bone. Artifacts which are typical, but less common are composite toggling harpoons, bone chisels, antler wedges, ground and polished "jadeite" adz blades, ground slate knives, whetstones, and ground *Mytilus californianus* shell knives and scrapers. Grinding and polishing are the important manufacturing techniques. Artifacts which are found but which are not typical are chipped stone artifacts which in some instances are clearly intrusive and in other instances are indicative of a slightly earlier time period.

Faunal Remains

Fish remains are common in all strata of all sites. A. D. Welander, Department of Fisheries, University of Washington, identified the following species: rockfish (*Sebastodes*) were the most common bones identified, and occur in all sites; the dogfish (*Squalus acauthias*) was identified by the dorsal fin spine which occurs in all sites; sculpin (family *Cottidae*, probably *Scorpaenichthys*) occurs at SJ–3, SJ–5, and questionably at SJ–25, SJ–185, and SJ–186; ling cod (*Ophiodon*) were found at SJ–2, SJ–3, SJ–5, and questionably at SJ–25; bones of a cod-like fish, probably *Myoxecephalus*, occur at SJ–2 and SJ–3; skate (*Raja*) is represented by a single bone from SJ–5. It was not possible to have any of the fish vertebrae, which are the most common fish bone found, identified. Many of them undoubtedly belong to the salmon which formed the mainstay of the historic Indian groups.

Bird remains are plentiful in all sites but identification was limited by time and the comparative material at hand. William Goodge (then at the Washington State Museum) identified the following: sea gull from SJ–25 and SJ–185; puffin from SJ–3: murre from SJ–185 and SJ–2; goose from SJ–3, SJ–25, and SJ–185; cormorant

TABLE 4. DISTRIBUTION OF IDENTIFIABLE MAMMAL BONE.

Mammal form	CATTLE POINT		ARGYLE LAGOON							
	Old Beach	*East Bluff*	*I*	*II*	*Jekyll's Lagoon*	*Moore*	*Garrison*	*Richardson*	*Mackaye*	*Total*
Columbia Black-tailed Deer	119	11	56	175	X*	13	145	52	62	633
Odocoileus hemionus columbianus										
Dog or wolf	4	8	8	23	X*	11	21	16	4	95
Canis sp.										
Harbor or Hair Seal	26	4		2	X*		9		9	50
Phoca richardii richardii										
American elk	2	1	1	1		8	8	1	16	38
Cervus canadensis										
Sea Lion		1?	1?				11			13
Eumetopias jubata										
Beaver			1			2				3
Castor canadensis canadensis										
Total	151	25	67	201		34	194	69	91	833

*Present, but of undetermined frequency.

from SJ–185 and SJ–2; eagle from SJ–186; duck from SJ–25 and SJ–185; and probably loon from SJ–185.

Shellfish remains form the greatest bulk of the faunal remains. Estimates taken in the field indicate that the various species of clam (*Saxidomus giganteus, Schizothaerus nutalli, Protothaca staminea,* and *Macoma nasuta*) predominate except possibly at Cattle Point where they occur, but in unknown frequency. Mussel were very common at SJ–3 and SJ–5. Saucer-shaped lenses of sea-urchin (*Strongylocentrotus* sp.) spines were found at all sites. Other species are of minor occurrence.

Mammalian remains occur in considerable quantity at all sites, but are most common at Argyle Lagoon. They were identified by comparison with the osteological collection at the Washington State Museum. No attempt was made to identify any ribs or vertebrae. The distribution and frequency are given in Table 4. Unfortunately the level bags from the main trench at SJ–3 were missing so no total count could be made. Of the 11 sea lion bones from SJ–25, ten probably belong to the same animal. These ten were found associated in Layer IIIb. The other bone came from Layer II.

CHRONOLOGY AND CULTURE CHANGE

The prehistory of the San Juan Islands from the Marpole phase in the first millennium B.C. to historic times has been described, and will now be discussed in the context of the prehistory of the Pacific Northwest in general. There was undoubtedly some occupation in the islands prior to Argyle Lagoon I or the Marpole phase component at Garrison, whichever is earlier, even though there is no concrete evidence of it. The southern terminus of the last glaciation, the Vashon, which is probably equivalent to the last maximum of the Wisconsin, the Mankato, is only about 200 miles to the south (Hanson 1947: 34). Logically any populations living on the fringes of the glacier would gradually follow as it receded. The early postglacial climatic conditions west of the Cascades were probably little different from those near the margins of the present day Alaskan glaciers and the forests probably advanced rapidly as the glaciers retreated (Hanson 1947: 113). Small groups wandering gradually northward as the areas became free of ice, as the forests grew, and as the salmon began their annual migrations up the rivers probably moved out into the islands. Fishing techniques *may* have already been in use as a result of adaptation to lake and river environments in adjacent unglaciated areas, although there is no artifactual evidence for this. There is a growing body of evidence for this first stage in the Pacific Northwest. Cressman (1957) has some evidence of periglacial occupation at Five-Mile Rapids on the lower Columbia starting some 11,000 years ago, followed by levels where site geography as well as the presence of thousands of fish bones clearly show a fishing culture.

Borden has another early culture at DjRi3 on the Fraser River dated at about 6000 B.C. where the occupants were certainly making use of the fish resources of the river although site geo-

graphy is the only clue to this practice. Neither site shows specific artifacts adapted to a fishing complex, but one must keep in mind that fish nets which are still widely used by the aborigines in these areas usually leave no archaeological traces. Perforated stones found at Cattle Point and other sites are interpreted as net sinkers, and I think rightly so, although the historic type of net sinker in the San Juans is an unworked egg shaped stone (Suttles 1951: 134). This is probably true elsewhere also. Wiers, basket traps, and most specialized fishing equipment survive only under conditions of favorable preservation.

More evidence of early occupation comes from the Lind Coulee site in eastern Washington where by about 7000 B.C., judging from the radiocarbon dates, man was camped by a sluggish stream or lake and eating bison meat not long after ice rafts had dropped boulders in the same deposit (Daugherty 1956: 234). The chipping industries from these sites consist of lanceolate points, knives, scrapers, and choppers which show a generalized relationship with other cultures of North America on this time level. In addition a barbed bone harpoon fragment from Lind Coulee and a small unilaterally barbed bone point from the early level of Five-Mile Rapids show the existence already at this early time in the Northwest of a *class* of artifacts which became much more important in the Marpole phase and later phases in Puget Sound and the Gulf of Georgia.

The time period between these early cultures and the Marpole phase is poorly known. The Five-Mile Rapids sites continue through this period and in Puget Sound the Deception Pass phase (Bryan 1957) probably belongs here, but they give no clue to what was happening in the Northwest to produce the Marpole phase. The factors which are most likely involved are a progressive adaptation to the environment coupled with the development in the Mesolithic and Neolithic cultures of the Old World of the customs of using and manufacturing artifacts of horn, bone, and stone by sawing, abrading, and polishing techniques, and the diffusion of those techniques and artifacts to the cultures of this area. Types differ, but change is a natural consequence of distance in time and space. In the Neolithic of Lake Baikal in Siberia in the Serovo period (3rd millennium B.C.) barbed harpoons with tang and lateral line guards were in use as well as polished adz blades and ground slate knives; in the following Kitoi period (2500–1700 B.C.) sawing of nephrite with slate saws appears (Michael 1958). The introduction of these items plus internal developments help account for the emergence of Marpole.

Culture change within the time period covered by the excavations, that is between the Marpole and San Juan phases, is expressed both by the changes in the items of material culture and by differences in adaptation to the environment. Presumably the former is a reflection of the latter. The large numbers of chipped stone projectile points from both Garrison and Argyle Lagoon, correlated with the quantities of land mammal bone from both sites, suggest a marked dependence on land hunting for food. The absence of composite fish hooks suggests either a lesser dependence on fishing or fishing by other than historically known techniques which can be documented archaeologically. One must not forget, however, that the setting is on an island which presupposes water transportation and that fish and sea mammal remains are found in all phases. The lack of shellfish remains in the lower strata at both Cattle Point and Argyle Lagoon is an enigma. Arrangement of the sites in a developmental sequence from less maritime adaptation to more maritime adaptation would certainly make these the earliest. However, the excavations at Argyle Lagoon are not really extensive enough, and too little is known of the manner in which shell middens accumulate to justify the conclusion that shellfish were not utilized. The loss of the chipped stone industry in the San Juan phase and its replacement by a grinding and polishing industry utilizing bone and stone can only be the result of historical processes. This replacement appears to have been a gradual process in which some activities associated with implements of ground stone and bone — namely fishing and sea mammal hunting — gained precedence at the expense of those activities associated with implements of chipped stone — namely land mammal hunting — until stone chipping went out of use completely. The hunting of land mammals itself survived, but with implements more frequently associated with maritime activities. There is no reason to believe that artifacts of chipped stone could not be adapted to a mari-

time economy, so purely functional reasons for this shift must be ruled out. In addition, there is the change from the predominant use of antler as well as chipped stone for projectile points in the Marpole phase to the use of bone in the San Juan phase. In Europe during the late Upper Paleolithic and at Star Carr antler was preferred as a raw material in the manufacture of spear and harpoon points, whereas in the later Maglemosian, bone was used almost invariably for these same classes of implements (Clark 1954: 181). One cannot but wonder if this parallel sequence is not due to diffusion particularly since there is a scattered distribution suggestive of continuity of barbed bone spear or arrow points across the top of the Old World and south along the western edge of North America. Correspondence in time depth, however, cannot at present be shown. One problem is that investigators do not always distinguish between bone and antler in their descriptions of artifacts.

In addition to change there is a certain continuity of culture from the Marpole phase sites to the San Juan phase. At Marpole, Borden has found evidence for a large multi-family dwelling which must certainly be related to if not identical with that of the historic Indian groups. A similar continuity is evident in wood working tools — adzes, mauls, chisels, and wedges. There is a continuity in art style also, but more toward what is considered classic Northwest Coast art than toward historic Salish art.

In the preceding paragraphs archaeological remains from the San Juan Islands have been described and discussed, and some hypotheses have been advanced. A fuller picture of the prehistory of the area and its relationships can only be gained by further excavation in the numerous rich shell middens which dot the shores and lagoons.

Acknowledgments. This paper is a completely revised and condensed version of a thesis entitled, "Archaeological Investigations in the San Juan Islands," which was presented in partial fulfillment of the requirements for the degree of Master of Arts at the University of Washington in 1954. The original was prepared under the direction of Douglas Osborne and Erna Gunther. Six of the sites, SJ–1, SJ–4, SJ–5, SJ–99, and SJ–25 were excavated between 1948 and 1951 by the summer field school in archaeology of the Department of Anthropology of the University of Washington under the direction of Carroll Burroughs. SJ–3 was excavated by Warren W. Caldwell and SJ–185 and SJ–186 by William Liston and Malcolm Forbes, graduate students. I am indebted to Charles Borden, University of British Columbia, for the radiocarbon dates and information on the current Fraser delta sequence, and for many hours of discussion on Northwest prehistory.

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University of Arizona
Tucson, Ariz.
March, 1959

STANLEY A. STUBBS

1906–1959

Most anthropologists can name, among their colleagues, a few whom they esteem much as a fisherman esteems his favorite pool. To a true fisherman, this means more than the catching of fish, although his time-tested conviction that there *are* fish in his pool — rare, distinguished fish, not to be found elsewhere — is an element which draws him to its banks again and again. But what also draws him is a quality of the pool itself — an honesty, perhaps, in the way it meets whatever he brings to it in his fishing. A man can wade such a pool all day, not make a catch, and go home happy.

Stanley Stubbs was like that: a pool of rare knowledge of many things in the American Southwest, but also something more, something in context which gave warmth to fact and stubborn halt to error as he saw them, and which transcended mere discussion of data. At his death — of a heart attack, at his home in Santa Fe on November 22, 1959 — the same tribute was paid him by professionals and amateurs alike, writing from all parts of the country. It was all that any man could wish for: equally to be honored for what he had given, mourned for the loss of what he no longer could give, and remembered with sincere liking and respect for what he was.

Stanley A. Stubbs was born in Albuquerque, June 10, 1906. In 1931, after graduation with a Bachelor of Science degree from the University of New Mexico the previous year, he joined the staff of the new Laboratory of Anthropology, in Santa Fe, as a field archaeologist. He was to remain with the Laboratory for 28 years, the whole of his professional life.

(Continued on next page)

Dirt archaeology was his first love. He came to know his native state well, from the time of his earliest surveys storing up its geography, geology, and surface evidence of prehistoric occupation in a memory later to be most useful to less peripatetic investigators. In particular, he learned its prehistoric ceramics, and in later years was on continuous call as local or consulting inter-areal judge, in this still incompletely adjudicated field.

He became Curator of the Laboratory in 1938, and upon the institution's merger with the Museum of New Mexico in 1947, he was named Research Associate. In 1950, Sylvanus Morley appointed him Museum Associate in Charge of Anthropology. In a reorganized Division of Anthropology, he became Curator of Collections in 1959.

With W. S. Stallings, Jr., in 1933, he excavated Pindi Pueblo, near Santa Fe — a landmark in the definition of many temporal traits of the area. He did pioneer work in the Gobernador, and near Alamogordo and in the Sacramentos, and later excavated near Albuquerque, in the Tesuque Valley, at Pecos, and at several historic sites in Santa Fe. Last year he worked two early Spanish mission ruins, at Quarai and Tabira, and at the time of his death was looking forward to more work at Pecos, this summer, to help follow up a lead of Kidder's.

But his interests, and special knowledge, extended far beyond the limits of archaeology. In its early years, the Laboratory was a true clearing-house of studies of Southwestern Indian culture — material, social, and esoteric — and Stubbs was at the center of them all. Every visiting and resident specialist was his tutor, knowingly or not, and he later pursued studies, on his own, which no-one else yet had touched. Word about him spread (fishers are great talkers), and increasingly, to his cluttered desk in the Laboratory, both experts and laymen began bringing their problems on matters ranging from kachinas to kiva patterns, pottery temper to modern turquoise rings, putative bayeta to impossible cord-marked sherds. Always, he gave ungrudgingly of his own time to this work of others, translating it in terms of work to be done, reports to be written, validities to be established — no matter by whom. His own publishing record suffered, in consequence. But the list of articles and major reports by others which acknowledge the use of "information obtained from Stanley A. Stubbs" would fill a good-sized volume.

He leaves his wife, Florence (Crile); a daughter, Mary Lou (Mrs. William J. Ross); and three grandchildren. He also leaves a lasting warmth in the memories of his many friends, the mark of his worth in the records of his profession, and the Southwest's past and present a bit better understood, by everyone, for his having been there and having been the sort of man he was.

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The fourth Kidder Medal is awarded to Charles C. Di Peso of the Amerind Foundation, a young scholar whose professional life has been marked by productivity achieved through dedication to one objective. This objective is concentrated research into that unspectacular flat shadowland of transition where the inferences of prehistory give over to, or are obscured by, recorded observations of living peoples and the events of documented history. He has labored diligently and has recorded the results promptly in a steady flow of detailed, yet imaginative publications, each of which he has enriched by blending archaeological inference with ethnological fact. He receives this award, and the professional recognition with which it is endowed, for his previous work in the southern deserts of the Southwest in outlining the late prehistoric cultures of the region and establishing their connections with historic tribes, and for his current cooperative venture with the Mexican government at Casas Grandes, Chihuahua, where so much is being learned and from which so much can yet be expected.

PREVIOUS ALFRED VINCENT KIDDER MEDALISTS

Alfred Marsten Tozzer, 1950; Earl H. Morris, 1953; Samuel K. Lothrop, 1956

FACTS AND COMMENTS

REJOINDER TO TAYLOR

RICHARD S. MACNEISH

ABSTRACT

In a review of MacNeish's *Preliminary Archaeological Investigations in the Sierra de Tamaulipas, Mexico*, Taylor claims that the sequence of phases is built largely on the evidence from Diablo Cave and that the method of analysis is based on the premise that one congery of artifacts equals one phase. MacNeish rejects these claims by reviewing the way in which he used single components and stratigraphically unmixed deposits from several sites to work out the phase sequence.

I WOULD LIKE TO THANK Walter Taylor (1960) for the kind words in his review of my recent monograph on archaeological work in the Sierra de Tamaulipas (MacNeish 1958). It is gratifying that he will have his advanced students use it and that he enjoyed it, but as he seemed to have misunderstood what I did in it, a rejoinder may be in order. His criticisms fall into two categories: (1) objections to what he believes were my premises and resultant methodology, and (2) a number of different opinions or interpretations concerning my materials from the Sierra de Tamaulipas.

Taylor's (1960: 435) main criticism concerns premises he assumes I made, one of which reputedly was: "a change in artifact inventory (however slight) plus a difference in excavation unit (however determined) is reason to establish a separable cultural entity which he generally calls a 'phase' and which he considers comparable with other cultural entities on a one-to-one basis without further analysis or qualification." Taylor, having assumed this was my premise, goes on to state that "the master sequence was built largely on the basis of the findings in Diablo Cave" and that by using a "one excavation unit — one cultural unit" premise for the interpretation of the materials, that I set up an unqualified sequence of phases. These units, he infers, were used for comparison with those from similarly ill-defined cultural units from other sites. This, he feels, led to the establishment of a multitude of simple cultural units on the basis of my "one congery — one phase" premise.

For those who have read my monograph carefully and understand it, please bear with me, while I refute Taylor's contentions. To do this I will briefly repeat what my premises actually were and show that the resultant methodology bears no resemblance to what Taylor imagines I used.

As indicated on page 9 of the Tamaulipas work, the major premise is that a distinctive congery composed of an adequate sample of artifacts and traits that occurs at one or more (pure) components, each of which represents an occupation, shall be the basis for establishing a phase. A primary corollary to this is that congeries of artifacts (however small) which come from excavation units (however defined) may *tentatively* and with definite qualifications be consigned to one of the established phases on the basis of limited similarities. A second corollary is that in cases where there are no established phases, distinctive congeries that occur at one or more (preferably more) components or site collections may be tentatively classified as belonging to complexes. Thus, it is immediately apparent that Taylor did not discern this major premise and somehow replaced it with premises something like the corollaries to it. He made this mistake in spite of the fact that I used the word *phase* as opposed to *complex*, *pure* components in distinction to possible, probable, and doubtful components or site collections; and I made a point of *not recognizing* certain phases until pure components occurred (for example, MacNeish 1958: 35, paragraph 2).

Now let me reiterate briefly how and on what basis the phases were established. This will further illustrate that the major premises were not what Taylor said they were, and that the master sequence definitely was not "based largely on the findings in Diablo Cave." In actual fact, three phases — originally called periods of the Pueblito culture (MacNeish 1947: 3–5) — were established in 1946, before I ever heard of Diablo Cave. On the surface of a house platform at Tm r 79, in a layer (1) above a burned floor and below the humus and burned fragments of house walls (representing a relatively short occupation) was found a distinctive congery. On the same house platform in Level 2, a large sample of a very similar congery was found in the 2-inch burned floor, which obviously represented a single short time occupation. This same congery occured in a third floor level on top of House Platform II at Tm r 78. These three pure components with large samples of almost the same congeries are the basis for the establishment of the La Salta phase. Later Tm c 322 and Tm r 323 with large samples of a very similar congery were considered *probable* components. They were given this less definite status because the materials came from a context that did not indicate a definite single occupation and thus, while supplementing the phase, were not necessary to its establishment. Tm r 80, Tm c 289, Tm r 90, Tm c 314 Layer 2, and House 2 of Tm r 78 (with small samples of what seem to be a similar congery found in either surface collection or in poorly understood stratigraphic context) were thought of as possible (qualified) components. Thus in the initial work it is apparent that neither the premises nor the method that Taylor conceived I used were in fact employed.

Next, the Eslabones phase was established on the basis of abundant materials of a new and distinctive congery found first in Level 3 (a house floor) at Tm r 86 and duplicated in two test pits in house-platform floors at Tm r 6. Supplementing these pure components were large samples of similar congeries in Tm r 86, Levels 1 and 2; Tm r 79, Levels 3 and 4; and from the surface of Tm r 304, all considered only probable components because the materials did not come from well defined occupational levels. Classified as possible components were the more poorly represented similar congeries from Layer 2 of Tm c 81, Layer 3 of Tm c 82, the surface from Tm

r 311, and the surface of Tm c 337 (all with poorly defined occupational layers). Laguna was defined at the same time, based on abundant materials of still another distinctive congery that occurred in pure components in Level 4 (a floor level), Level 5 (a floor level), Level 6 (a floor level and pit) of Tm r 86, and Levels 1–3 (a house floor and a thin mantle of refuse between two houses) from Tm r 172. Surface collections and materials from poorly defined occupational layers of similar material from Tm r 187, Tm r 262, Tm r 301, Tm r 88, Tm r 302, Tm r 310, were probable components (not necessary to the establishment of the phase). Layer 1 of Tm c 174, Tm r 324, Level 7 of Tm r 86, Tm c 328, Tm c 338, Tm r 185, Tm r 186, Tm r 223, Tm r 188, Tm r 195, Tm r 196, and Tm r 194 were hesitatingly considered components of the phase, either because of limited sample of what seemed to be this same congery or because the samples occurred in poorly defined occupational contexts.

While all three of these phases were established in 1946, the Los Angeles phase was only recognized as a complex at that time. The Los Angeles phase was established in 1949 on the basis of materials of still another distinctive congery from Level 1 (a four-inch layer of refuse having postholes extending down from it) at Tm c 83, plus similar congeries from three floors (Level 1) from Tm c 314 and from the ash level of Tm c 81. Layers 1 and 2 of Tm c 82, Layers 2 and 3 of Tm c 83, Tm c 198, and Tm c 316 had similar congeries and were considered probable components, while collections (often smaller and less similar) from the surface of Tm c 174, Tm c 325, Tm c 294, Tm c 308, Tm c 220, Tm c 221, Tm c 288, Tm c 84, Tm c 222, Tm c 290, Tm c 292, Tm c 311, Tm c 85, Tm c 293, Tm c 312, Tm c 197, Tm c 327, Tm c 326, Tm c 320, and Tm c 338, were, at best, possible components.

All this detail is dreadfully dull, but it does prove — specifically by example — that I did not proceed as Taylor claims. In 1949, the Lerma phase was established on the basis of still another distinct congery found in other pure components, namely the sealed-in Zone D (with its two floors, Levels 5 and 6) of Tm c 174, and the terra rosa layer, Zone C (which included two hearth areas Floors X and Y), at Tm c 81. Tm c 305 was a surface collection while Tm c 81 (Layer 4) and Tm c 174, Layer 4) were obviously mixed, though one of the mixed elements may have been Lerma. La Perra was next established on the basis of a distinctive congery in the gray ash zone (D), with a pit and burial in it in Level 8 of Tm c 315 as well as in the definite vegetable floor layer (Layer 3) at Tm c 174, and the vegetable lenses (one to four floors) in Layer 2 of Tm c 174. Supplementing these pure components were similar congeries in Level 9 of Tm c 315 and Layer 5 of Tm c 82, while Tm c 175a, Tm c 189, and Tm c 317 were possible components.

Almagre was not established as a phase until 1955, when another distinctive congery was found in the white ash floor (Level 5) as well as in the dark refuse occupational layers (6, 7) of Tm c 315. Tm c 82, Layer 4 was a probable component while tentative or possible components were Tm c 314 Layer 3, Tm c 175, Tm c 179, Tm c 300, Tm c 291, Tm c 305 west, Tm c 321, and Tm c 339. Nogales was not established as a phase until a distinctive congery was found in the fossil bone part of the sandy refuse Zone D, with its pits in Tm c 314, though Layer 3 of Tm c 81, layers 6 and 7 of Tm c 82; Level 4 of Tm c 29 has similar materials in layers that could not be established as coming from definite occupational zones. Tm c 89, Tm c 290a, Tm c 313, Tm c 176, Tm c 177, Tm c 30, Tm c 32, Tm c 21, Tm c 39, Tm c 169, Tm c 163, Tm c 190, and Tm c 22 were possible components.

Thus, neither the premises nor the method Taylor assumes I used were in actual fact employed. How or why he arrived at these misconceptions I do not know. A number of possibilities come to my mind: that my presentation and writing were not clear; that his reading was not careful or thorough enough; or that because of Taylor's original skepticism a bias was formed that warped his judgment and ability to analyze.

Now let us take up some of Taylor's opinions about the monograph and my analysis. First, is the statement that in my cross-cultural comparisons (of artifact types) I am "too trusting, too depending, even naïve." Taylor uses as an example "the so-called Teotihuacan point" in Diablo Cave associated with Eslabones materials, which, because of similarity in form, material, and manufacturing technique to those from the Teotihuacán time period, led me to infer that Eslabones and Teotihuacán overlapped in time. I would like to point out that Eslabones had (a) mold-made figurines like Teotihuacán and (b) many obvious ceramic similarities to Huasteca period III that Ekholm has shown to be related to Teotihuacán; and (c) that in 1958, Nicholson found actual Teotihuacán trade sherds at an Eslabones site (Tm r 304). Was my inference really so bad, and are the rest of them of this caliber?

Let me also add that the establishment of cross-cultural relationships is based on comparison of archaeological materials from different areas, and here I had difficulties. In fact, I would like to ask Taylor where are the answers to my letters of May 21, 1951, and December 10, 1956, suggesting and begging for exchanges of archaeological information between Coahuila and Tamaulipas? Finally, I would like to point out that if I erred in pushing my cross-cultural relationships too far, I would rather have done this (if only for the fact that I may lead others to test these relationships) rather than to have given no information at all, or to have given opinions so conservative that they would have stimulated no one.

In his closing section Taylor has offered three more opinions. I agree in part with some of these, but I would like to point out our differences and the reasons for them. First, Taylor suggests that the cultural sequences

and interactions in Tamaulipas are more complicated than I give them credit for being. When we get a more complete knowledge of the cultural phases, their interactions, the total material culture and social aspects of the phases, and a thorough knowledge of the various ecological factors, a very complicated situation will undoubtedly be found. Quite frankly, with only preliminary investigations, I saw no reason for speculating about their complexity; I presented the findings as simply and as thoroughly as I could.

Second, Taylor believes that the cultural deposits of my excavated caves were not all as simple as I say they were. In actual fact, I only say that the deposits of Tm c 174 were not complex and that (part of) Tm c 81 was relatively simple. Tm c 82, Tm c 314, Tm c 315 and all 18 surveyed sites were definitely not simple (and again I saw no need to emphasize this fact in my writing). The very fact that out of the 32 excavation units in the caves only 11 could be considered pure components should illustrate the point that deposits were complex. If Taylor wants a definite statement, here it is: Cave deposits for the most part are complicated, and on the basis of survey data I try to dig the least complex ones.

Third, Taylor (1960: 438) believes that my phases might "more realistically and more significantly be grouped into three units." Inasmuch as there is a similar tentative classification in my report (MacNeish 1958: 166–7, Table 22), Taylor is either not very original, or else he did not read the report very carefully. I think that the small units or subdivisions are a more realistic and significant grouping at present for a number of reasons. First of all, it is more practical to analyze starting with an artifact, the artifact assemblage, then phase, and then later, finally arriving at larger groupings such as traditions when more complete data become available. Second, Taylor (1948: 127) has already pointed out that "the publication of . . . empirical descriptions [of the small units] . . . serves to acquaint . . . colleagues of . . . findings, to elicit from them the antithetic or corroborative information urgently required, and to provide the general literature with comparative material with which to lend depth and significance to other finds from other sites." Finally, I do not see the merit of a classification such as Taylor's that lumps Lerma with Almagre when there are only six general types held in common out of 43, and when the two have entirely different modes of subsistence (hunting versus agriculture) and community patterns (nomadic versus semi-sedentary micro-bands).

In conclusion, I am appalled that Taylor, whose reputation as a skillful and influential critic of New World archaeological endeavor is well established, wrote the review that he did, especially since he apparently spent considerable time studying the report. I sincerely hope that he will show better ability to analyze archaeological materials in his long-awaited Coahuila monograph than he has revealed in his review of my Tamaulipas report.

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National Museum of Canada
Ottawa, Ont.
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ANCIENT MESOAMERICAN MORTARS, PLASTERS, AND STUCCOS: THE USE OF BARK EXTRACTS IN LIME PLASTERS

Edwin R. Littmann

Abstract

Mesoamerican masons have used an extract from the bark of such trees as the *chucum*, *chacté*, *chacah*, and *jabín* in the preparation of lime plaster since prehistoric times, reportedly to increase the workability or strength of the lime and to reduce cracking in the plaster. Experiments involving the use of plasters prepared with these high tannin-content extracts show that the extracts have an effect on the properties of lime plaster probably by stabilizing the system during drying.

THE CONTINUED USE of certain bark extracts in the preparation of lime plaster in Mexico from prehistoric to modern times has been of interest to archaeologists for some time and has been noted on several occasions by Littmann (1957), Morris, Charlot, and Morris (1931, Vol. 1: 224), Satterthwaite (1943: 10–11), Standley (1930: 232, 280, 284), Thompson (1932: 184), and Tozzer (1941: 175–6, 198). It is, therefore, of interest to determine whether the use of these extracts in any way modifies the characteristics of a simple lime plaster. The most commonly reported extracts are those of the following trees: *Chucum* (*Pithecolobium albicans*), *chacté* (*Caesalpinia platyloba*), *jabín* (*Pescidia communis*), and *chacah* (*Bursera simaruba*). Fustic has been noted as a color for plaster paints, as has *achiote* (Thompson 1932). Through the kindness of Alberto Ruz L., samples of the woods known by the local Maya names were obtained. It has not been determined if the samples received actually correspond with the correct botanical descriptions, and at least one, *chacté*, is in question. This point is relatively unimportant since the woods are ones that yield extracts for present-day use.

The bark extracts are said to improve the workability or strength of the lime and to reduce cracking in the plaster, characteristics which should be reflected in other and more easily determined properties. Since the addition of the bark extracts to lime produces an initial if

not permanent color change, and since woods of the species used are known to contain natural coloring matters or tannins, it is very probable that some chemical reaction between the extract and the lime takes place. In order to determine the manner in which bark extracts influence the curing and aging of lime plasters, a series of simple experiments was devised which included examinations of the surface characteristics of the plasters prepared, shrinkage, rate of cure, and porosity. No attempt was made to isolate and identify the constituents of the bark extracts other than to make some simple tests which are often applied to tannins and tannin-like materials to demonstrate their presence.

Before starting the experiments, it was necessary to establish that a simple infusion of the barks used would provide an amount of extractive sufficient to have any measurable effect other than to contribute some color. Since no records are available to describe how the extracts were made in ancient times, exhaustive extractions of samples of bark, sap, and heart woods were made with water in a Soxhlet extractor and the extracts evaporated to dryness on the steam bath. The yields of extracts are shown in Table 1. These results show that even simple extraction might be expected to yield a measurable quantity of extractive and that the bark is the richest source.

The experiments devised to study the influence of the bark extracts on lime plaster were based upon the preparation of "standard" samples by the following procedure. The extracts were made by infusing 5 g. of the air-dried barks with 50 ml. boiling water and allowing the mixture to stand for several days. If fungus growth appears, the infusion should be discarded and a fresher sample used. The infusion was filtered through cotton prior to using. Plaster was prepared by thoroughly mixing 5 g. of commercial, hydrated lime with 4 ml. of the extract. The mass was then molded in a tapered polyethylene

Table 1. Yields of Extracts from *Chucum* and *Chacté*.

	Yield (%)	*Color of Solution*
Chucum		
Bark	23.5	Dark red
Sap wood	3.5	Yellow
Heart Wood	6.0	Dark red
Chacté		
Bark	13.5	Dark red
Sap wood	6.5	Dark orange
Heart wood	7.0	Dark red

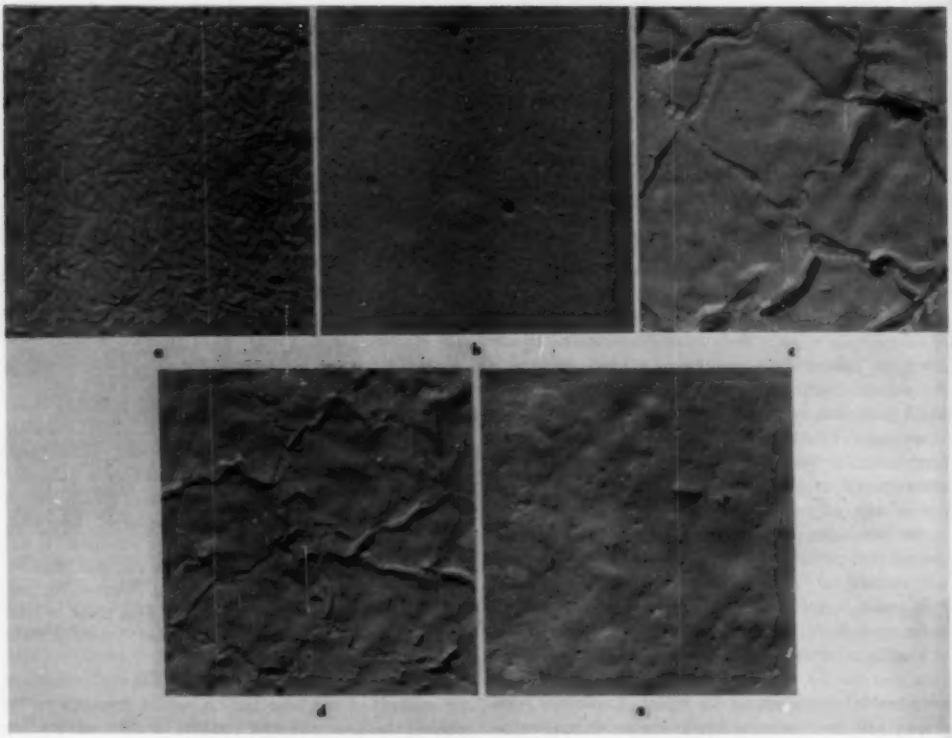

Fig. 1 [Littmann]. Plaster surfaces before aging. *a*, blank; *b*, *chucum*; *c*, *chacté*; *d*, *chacah*; *e*, *jabín*. Magnified about 12 times.

ring measuring 14 mm. high by 51 mm. inside diameter at the small end, cut from a drinking cup. The mold was placed upon a piece of aluminum foil and filled with small, successive portions of the wet plaster, each addition being followed by tapping the mold sharply against the table top to eliminate air bubbles. After the mold was filled, the surface of the plaster was smoothed with a spatula and leveled with the top of the ring. After 24 hours, the plaster had shrunk from the side of the mold so the latter could be lifted off. As a control, a specimen was made with water instead of an extract.

The surface characteristics of the samples after the 24-hour drying period and before appreciable curing had taken place are illustrated in Figure 1. The surface of the blank (control) is covered with a series of ridges and valleys but showed no evidence of individual flake formation. The *chucum* surface was very smooth and unbroken, whereas the *chacté* and *chacah* surfaces showed over-all flake formation, each flake being separated from its neighbor by definite cracks which exposed an interior both duller and more porous than the flake. The *jabín* surface was similar to the *chucum* but somewhat rougher.

In the course of preparing the "standard" specimens, it was observed that the shrinkages in diameter were not uniform and that some concave upper surfaces had developed. Measurements describing these effects are shown in Table 2 in which the depth of the surface depression is a measure of the concavity observed. It is evident from the figures in Table 2 and the photographs in Figure 1 that the extracts exerted some effect other than providing a liquid medium with which to mix the lime. The *chucum* extract, in particular, appeared to facilitate the working of the plaster in that it tended to leave a more stable surface once the plaster had been worked. It is also interesting to note that the shrinkage is not progressive after drying took place.

TABLE 2. SHRINKAGE AND CONCAVITY OF MOLDED SPECIMENS.
(All dimensions in mm.)

	Diameter			*Shrinkage*	*Surface*	
	Original	*1 Day*	*19 Days*	*%*	*Form*	*Depression Depth*
Blank	51.0	46.0	46.5	8.8	Wavy	0
Chucum	51.0	48.5	48.5	4.9	Flat	0
Chacté	51.0	49.0	48.5	4.9	Concave	0.5
Chacah	51.0	49.0	49.5	3.0	Concave	1.0
Jabín	51.0	49.5	49.5	3.0	Concave	2.0

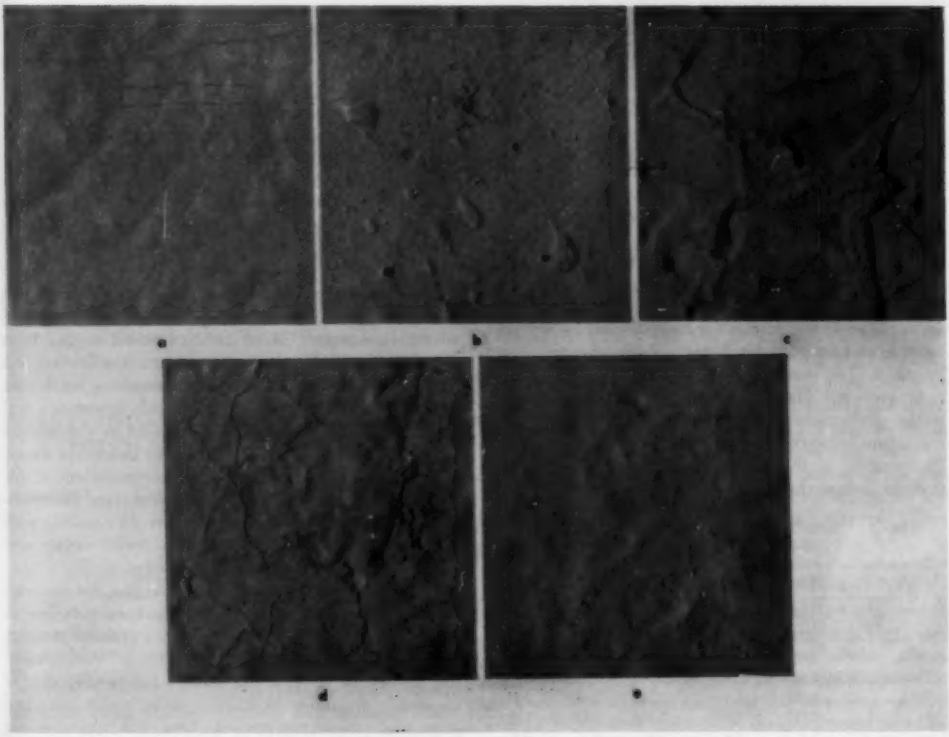

FIG. 2 [Littmann]. Plaster surfaces after 26 weeks aging. *a*, blank; *b*, *chucum*; *c*, *chacté*; *d*, *chacah*; *e*, *jabín*. Magnified about 12 times.

While all the extracts were rather highly colored, only the one from *chucum* yielded a plaster with a reasonably dark color which changed from a purplish tan when first added to the lime to a warm, red buff after a few minutes. This color was retained throughout the life of the specimen. The *jabín* extract produced a similar but much lighter colored plaster and one which, after drying, seemed to be more highly concentrated in the upper, exposed surface. The specimens upon which these observations were made were set aside for further aging tests as will be described later.

To determine the effect of the bark extracts on the initial rate of cure or carbon dioxide absorption, small aluminum cups were filled with plaster made as previously described. After drying overnight they were oven-dried at 110–120°C. for one hour, cooled to room temperature, and weighed. Each sample was then moistened with 0.5 ml. water, the drying and weighing cycle repeated daily, and the results obtained recorded in Table 3. Figure 3, in which the percent gain was plotted against time, shows that there are appreciable differences in the rate of curing or carbon dioxide absorption and that the extracts exert a retarding effect, most pronounced in the cases of *chucum* and *chacté*.

The long range effects of the bark extracts on lime plasters were observed by subjecting the "standard" specimens to the following conditions of aging which simulated those obtaining in a tropical rain forest area. A preliminary cure was given the specimens by allowing them to stand in the air for one month. They were occasionally moistened with water to accelerate carbon dioxide absorption. A small section was then sawed off and allowed to cure dry for the duration of the experiment. The larger sections were then placed, smaller diameter down, on wet cotton in a sealed jar and allowed to stand at room temperature for 10 days, after which they were allowed to air-dry for one week. During this initial wet storage period, rather large cracks developed in the blank and *chacté* specimens. The sections were again placed in wet storage for an additional 21 days and again allowed to dry for 5 days. After another period in wet storage, they were set out of doors (April) so as to receive full sunlight during the daytime. After 26 weeks of alternate warming and cooling (October), the specimens were removed from the jars and air dried. Photographs of the specimen surfaces (Fig. 2) show that no radical changes had taken place.

Table 3. Carbon Dioxide Absorption of Plaster Samples. (Sample Weight in grams)*

Hours	*Blank*	*Chucum*	*Chacté*	*Jabín*	*Chacah*
0	2.247	2.346	2.246	2.333	2.342
24	2.270	2.377	2.268	2.363	2.369
48	2.287	2.402	2.286	2.385	2.389
72	2.306	2.429	2.306	2.409	2.412
95	2.326	2.455	2.324	2.432	2.433
143	2.354	2.494	2.353	2.469	2.466
Total Gain (%)	6.4	4.8	5.8	5.3	4.8

* Corrected for weight of aluminum cup.

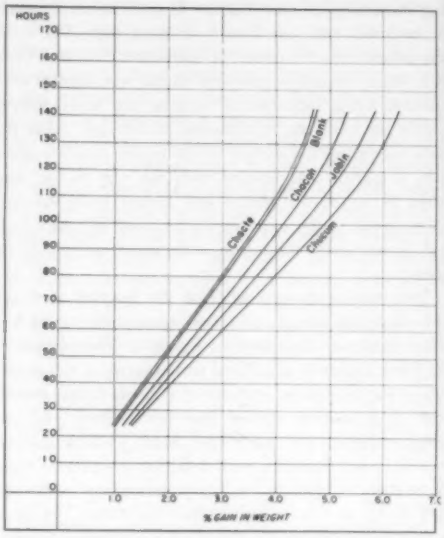

Fig. 3 [Littmann]. Rate of carbon dioxide absorption.

The actions of the bark extracts previously described were concerned primarily with exposed surface phenomena. It was therefore of interest to see if any effects were observable on the interiors of the samples. Such effects could result in changes or differences in crystal structure of the cured plaster, density, porosity, and so forth. Because of the difficulty of preparing surfaces for crystallographic examination and of determining apparent density — because of the absorptive nature of the plasters — determinations of porosity were made to detect any observable effects on both the dry and wet aged samples. Small samples (1–2 g.) of the plaster, broken from the "standard" specimens, were weighed and submerged in water under reduced pressure obtained by an ordinary laboratory aspirator. After bubbles ceased to rise from the sample (30–60 min.), the suction was broken and the sample weighed in a stoppered weighing bottle and after gentle blotting with a soft cloth to remove surface water. The porosity was calculated as the percent gain in weight for each sample, and the results are shown in Table 4. It should be noted that determinations of this type are not the most precise. Nevertheless, the minimum variations from the dry porosity do coincide with the minimum surface deformations noted earlier and tend to correlate with the rate of curing.

In the light of the foregoing observations, the evidence is reasonably good that the use of bark extracts has an effect on the properties of lime plasters, probably through a stabilization of the system during curing. Variations in the method of working the plasters before they dry, as apparently was done in ancient times, could introduce other phenomena not studied. One such characteristic is the gloss and hardness of the exposed surface. The gloss of the *chacté* and *chacah* samples was, for example,

TABLE 4. POROSITY OF PLASTER SPECIMENS — DRY AND WET AGING.

	Blank		*Chucum*		*Chacté*		*Chacah*		*Jabín*	
	Dry	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*
Gain, %	27.2	30.1	50.9	51.0	39.6	43.1	52.2	57.0	54.5	53.4
Differential	+3		0		+3		+5		-1	

much greater than that of the *chucum* and *jabín* specimens. It is possible that continued working of the surfaces of the former two would eliminate the flaking and produce an almost glossy appearance. It is evident from the above discussion that several questions remain unanswered, as, for example, the exact nature of the bark extracts which probably form chelates with calcium and magnesium compounds. This should form the basis of an interesting investigation.

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ESSO MEXICANA
Mexico 7, D. F.
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ADDITIONAL RONQUIN SITES IN THE MIDDLE ORINOCO VALLEY

CARROLL L. RILEY AND CHARLES W. OLVEY

ABSTRACT

The site of Pueblo Viejo extends knowledge of Ronquín-style ceramics farther east along the Orinoco than hitherto reported and provides new information on Ronquín settlement of the south bank of the Orinoco River. Laja de Manapiri adds another prehistoric settlement to the relatively thick cluster in the Caicara-Parmana area. Both sites contain Late Ronquín ceramics in a variety of forms including vessels, adornos, and figurines. Early Ronquín material is found at Laja de Manapire and is probably present at Pueblo Viejo. The Middle Orinoco is important archaeologically because of the possibility that the Ronquín styles link the Antillean area and northern Venezuela with the Guianas and the Upper Orinoco–Amazon region.

THE CERAMIC STYLES known as Ronquín were first identified in a systematic way by Howard (1943) in excavations and survey at sites in the vicinity of the Orinoco River town of Parmana, state of Guárico, Venezuela (Fig. 1). The most extensive work was done at the site of Ronquín, hence the name. Previously, Petrullo (1939) had reported similar ceramic material from the Arauquín area about 100 km. upstream from Ronquín. Later Riley (1953) reported surface collections in the state of Bolívar which extended knowledge of Ronquín style to the south banks of the Orinoco (compare Rouse 1953: 42). The Bolívar sites were Cedeño just east of the present town of Caicara de Orinoco and Punta Brava some 18 km. east of Caicara. The site of Las Trincheras on the Caura River has been independently reported by the Rev. Charles W. Olvey of Caicara and by Captain Felix Cordona of Carácas, Venezuela. Though not listed on the map (Fig. 1) it seems probable that Las Trincheras is also a Ronquín site.

In recent years, Olvey of Caicara has had the opportunity to visit two additional large sites both showing Ronquín style ceramics. One of these, Pueblo Viejo, is on the south side of the Orinoco, some 22 km. east of the town of Las Bonitas (thus 30 to 35 km. east and across the river from Parmana). The other site, Laja de Manapire, is on the Guárico (north) side of the Orinoco across the river from Punta Brava. The collections from the two sites consist mainly of adornos, figurines, handles, and a few sherds, both decorated and plain. This is, of course, a selective sample and so no systematic surface analysis of ceramics can be made. What is intended here is to describe such material as is available in order to fit these sites into the general mid-Orinoco archaeological picture.

The modern central Bolívar town of about a hundred inhabitants is near the site of an older, ruined Spanish settlement. The sherd area at Pueblo Viejo is along the banks of the Orinoco adjacent to the modern town. Ceramic material is washing out of the upper bank of the Orinoco for an area of some 700 m. and the sherd area extends for at least 1 km. back from the banks of the river. Because of extensive undergrowth, no attempts were made to ascertain the full extent of the site. As at Cedeño, sherds seem to be washing out approximately 1 m. below the top of the uppermost banks (Riley 1953: 265).

The small collection from Pueblo Viejo is entirely of Ronquín style ceramics and mostly (or wholly) of Late Ronquín material. The collection includes rim sherds, adornos, lugs, vessel or figurine legs, and figurines, both animal and human. The decorated sherds are all of Late Ronquín style and all have rather typical geometric designs. The adornos are quite exotic. They include human faces with coffee-bean eyes and mouths made with a single gash probably produced by drawing a blunt stick laterally across the face (Fig. 2 *a*). In one speci-

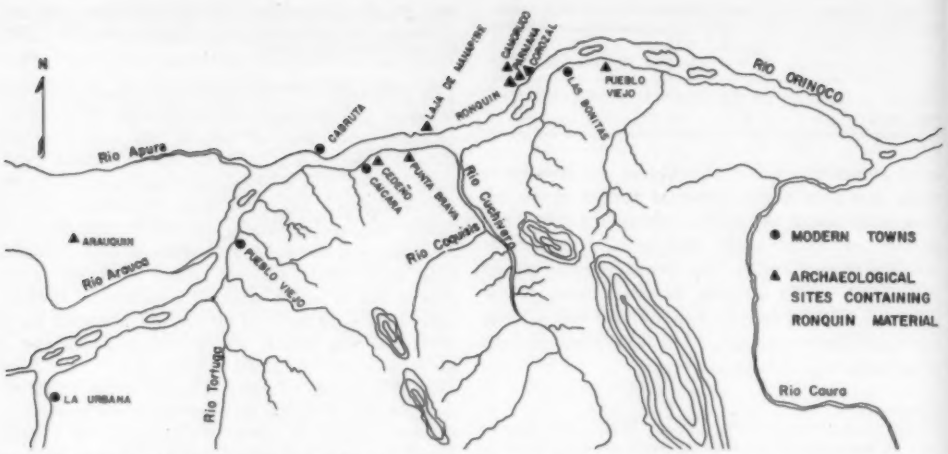

Fig. 1 [Riley and Olvey]. Map of the Middle Orinoco River showing the distribution of sites containing Ronquín ceramics. The straight-line distance from Arauquín to Laja de Manapire is about 100 km.

men, the ears are indicated by pulling out the clay on either side of the face. An impression with a hollow cane tip outlines the interior of the ear or, possibly, represents an ear ornament. Another human-like figure made in the same way has blunt tubular "horns" made with a cane imprint. Other adornos include animals and birds.

There are two molded figures, one a flattened tubular human figurine some 12 cm. in height. The arms and legs are missing and the body is too battered to identify the sex though facial features are well outlined. In general appearance, it strongly resembles a figurine found at Cedeño (Riley 1953: 267). The back of the figurine has a hollow depression (5 by 1½ cm.) running lengthwise down the back. The second figurine is that of an animal, possibly a crocodile. The features are worn almost beyond recognition but one striking feature is the over-all marking by cane-tip imprints. In fact, the whole group of ceramics at Pueblo Viejo is characterized by extensive use of this method of decoration.

One unidentified piece is probably a fragment of a rocker or cylindrical stamp (Fig. 2 *b*). The exterior decoration is made by cutting out the background to a depth of some 5 mm. leaving raised geometric designs somewhat reminiscent of the Late Ronquín incised designs on vessel exteriors (for a possible parallel, compare Petrullo 1939, Pl. 30 *a*, *b*).

In the Pueblo Viejo collections examples of both Cedeño Types 1 and 2 of the Late Ronquín style are found. Type 1 is characterized by gray or brown paste heavily mixed with organic material and very poorly fired. In the paste are sponge spicules of the genus *Spongilla* often occurring in large bundles. Type 2 is light terra cotta sand-tempered pottery, extremely chalky and crumbly to the touch. It is very porous — perhaps due to high firing of a clay that originally had considerable plant material. The spicules of *Spongilla* are present but are scattered, and somewhat broken, probably in the preparation of the clay. One possible example of Early Ronquín ceramics is a much battered bird adorno. Though it falls within Howard's general description of Early Ronquín it does contain scattered sponge spicules in the paste (spicules are not characteristic of Early Ronquín material at Ronquín and at Cedeño). No painted ceramics of any sort were found at Pueblo Viejo.

The Laja de Manapire, a large rock on the north bank of the Orinoco, is visible for some 15 km. up and down stream. Directly behind the rock is an open meadow of some five acres, on ground high enough to prevent flooding during high water. The meadow and the rock (*laja*) constitute the site. Sherds are found over the entire area though not in large quantities. Two test pits in the meadow indicated that the main sherd level was at about 65–70 cm. below the present surface.

In the tiny collection one decorated rim sherd is Late Ronquín (Fig. 2 *c*). Two other plain rim sherds are also probably Late Ronquín. On the other hand there are

Fig. 2 [Riley and Olvey]. Ceramics from Pueblo Viejo and Laja de Manapire. *a*, human-face adorno-projection from pot rim, Pueblo Viejo; *b*, rocker or cylindrical stamp, Pueblo Viejo; *c*, rim sherd decorated in Late Ronquín style, Laja de Manapire. *a*, about 5 cm. high; others to scale.

several sherds of what seems to be Early Ronquín. One, a lug handle, is covered with white paint and another sherd has red-brown paint. Several other polished plainware sherds are probably in the Early Ronquín tradition. Like Early Ronquín sherds from Cedeño these have inclusions of quartz and feldspar probably added deliberately as temper. As at the Pueblo Viejo, Cedeño, and Ronquín sites, Late Ronquín material from Laja de Manapire contained sponge spicules in the paste. However quantities of sponge spicules also appear in all the Early Ronquín specimens.

Other Sites. Two other sites in the area containing Indian material were noted, but no collections were made. One of these is near the present settlement of La Urbana, some 100 km. upstream from Caicara on the east bank of the Orinoco. Another site is a second Pueblo Viejo about half way between La Urbana and Caicara, also on the east side of the Orinoco, approximately opposite the mouth of the Arauca River.

Information on the Ronquín styles is important in part because of the crucial position of Ronquín in a delineation of the prehistory of northeast South America. The farflung relationships of Early Ronquín (with the Lower Orinoco area, Trinidad, and the Antilles), and Late Ronquín (with the Upper Orinoco and the Brazilian Guianas) suggest that the Orinoco River was the route for a movement of culture traits between the Amazon drainage and the Venezuelan-Antillean area (Rouse 1953: 43–44). Ronquín sites may also provide clues to the interchange between Tropical Forest peoples and the cultures of the Circum-Caribbean. The Pueblo Viejo and Laja de Manapire sites increase our knowledge of the Ronquín styles on the south side of the Orinoco River. In addition, the area of Ronquín is extended eastward, thus narrowing the gap between Ronquín and the well known styles of the Lower Orinoco where Ronquín contacts seem to have occurred. Finally, these new sites help document the flourishing pre-Spanish cultures in an area that may have been largely deserted by native populations at least by early historic times.

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TEMPORAL PLACEMENT OF ALMA NECK BANDED*

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ABSTRACT

Alma Neck Banded has long been considered to be a component of Mogollon 1 and Mogollon 2 horizons. Present evidence indicates, however, that this pottery type is a horizon marker for Mogollon 3 when it does not occur in the same context with Three Circle Neck Corrugated and Mangas Black-on-white of Mogollon 4. Apparently Alma Neck Banded first appeared in the southwestern United States between A.D. 600 and 700 and continued to be made until about 950. It is still difficult to determine the order of temporal priority between Alma Neck Banded and Kana-a Gray.

ALMA NECK BANDED (Haury 1936a: 35, 1940: 80–3) is one of the pottery types of Mogollon Brown ware (Colton and Hargrave 1937: 44–6) and was first described on the basis of occurrences in southern New Mexico. A discussion of the dating of Alma Neck Banded with particular reference to phase placement is warranted for a number of reasons: (1) it can be demonstrated that on the basis of present knowledge Alma Neck Banded should not be considered as a legitimate component of Mogollon 1 or Mogollon 2 (Wheat 1955: 11, 185) ceramic complexes; (2) once this has been accomplished it becomes possible to designate Alma Neck Banded as a horizon marker (Parsons 1957: 100) for Mogollon 3, when it does not occur in the same context with Three Circle Neck Corrugated (Haury 1936a: 36–7) and Mangas Black-on-white (formerly called Mimbres Bold Face Black-on-white; Haury 1936a: 22–7; Breternitz 1959: 30); (3) the correct temporal placement of Alma Neck Banded is necessary before the problem of Alma Neck Banded versus Kana-a Gray (Colton and Hargrave 1937: 195–6) priority can be sensibly approached.

By way of orientation it will be well to outline the steps by which Alma Neck Banded has been accorded Mogollon 1 and Mogollon 2 status in the archaeological literature of the Southwest. Following this, all of the available evidence pertinent to the phase placement of Alma Neck Banded will be presented and examined.

Twenty years ago pioneer work on the Mogollon culture was still in progress. It seemed quite logical at the time to make several assumptions, suggestions, and predictions to serve as working hypotheses until new evidence should indicate other interpretations. A surprisingly large number of these early working hypotheses set up in the late 1930's and early 1940's either have been verified by subsequent evidence or have not been controverted by new data. It is not surprising that a few of them have had to be revised or discarded altogether.

* Adapted from a discussion which appeared in my doctoral dissertation (University of Arizona, 1959), Cultural Implications of Style Trends in Southwestern Prehistoric Pottery: Basketmaker III to Pueblo II in West Central New Mexico.

One of the early working hypotheses stated, in effect, that Alma Neck Banded appeared in the Georgetown phase of late Mogollon 1 and possibly even earlier (Haury 1936a: 35, 42–3; 1936b: 98; 1940: 80–3, 94). This was used by other workers in the Mogollon area (Martin, Rinaldo, and Antevs 1949: 210, 212, Fig. 78; Martin and Rinaldo 1950a: 360; Martin and others 1952: 56–8). Meanwhile, two mutually exclusive developments have taken place: (1) a considerable amount of work in early Mogollon horizons, particularly during the last 15 years, has failed to produce evidence of Alma Neck Banded in horizons of Mogollon 1 or Mogollon 2; (2) some of the more recent publications in southwestern archaeology have uncritically presented the original Alma Neck Banded hypothesis as established fact (Martin and others 1952: 56–8; Wheat 1955: 72, 79, 101–3, 219). In the light of these developments, a review of all of the evidence and a reassessment of our ideas concerning Alma Neck Banded appear necessary.

At Mogollon Village and Harris Village (Haury 1936b), phase assignments were given to the excavated houses as follows: for Mogollon Village, one Georgetown phase house and five San Francisco phase houses (one of which was occupied, if not built, during Three Circle phase times); for Harris Village, three Georgetown phase houses, two San Francisco phase houses, and four Three Circle phase houses. Phase assignments were made on a consideration of architectural type and the ceramic complexes represented by sherds found on or within 10 cm. of the floors of these houses (Haury 1936b: 12, note 1). In the Southwest this technique has proven merit. Ceramic complexes from the floor and floor fill of all pit houses assigned to the Georgetown phase at both sites contained no sherds of Alma Neck Banded (Haury 1936b: 12, 54, 56). Sherd counts from higher fill in houses of a mixed occupation site are notoriously unreliable indicators of correct ceramic associations because of the facility with which later sherds can be deposited in earlier, abandoned houses through drift, float, the use of abandoned structures for trash pits by later occupants of the village, by means of intrusive burials, or due to any one of several agencies. Fill sherds are not reported for the Mogollon Village structures, but at the Harris site, a multiple occupation site, in the Fill of Type I (Georgetown phase) houses were three sherds of Alma Neck Banded and three of Three Circle Neck Corrugated (Haury 1936b: 133). This appears to be the basis for suggesting that Alma Neck Banded might have appeared in the Georgetown phase, but it is not sufficient evidence to establish it as a fact.

Using the Bradfield (1931) report on Cameron Creek Village, Wheat (1955: 74–5) found that by correlating specific houses with specific illustrated vessels listed as coming from them, it was possible to assign these houses and the ceramic complexes in them to San Francisco, Three Circle, and Mimbres phases. However, it is not possible to make the correlations for the earlier house types and ceramic complexes at Cameron Creek, since Bradfield did not identify specifically the pottery associated with these earlier houses. Consequently, the Cameron Creek Village data are insufficient for the purposes of the problem at hand.

Luna Village, excavated by Hough (1919) needs to be mentioned briefly because Gladwin (1948: 144–5) placed it in Mogollon 1. Wheat (1955: 100) and Danson (1957: 39) have demonstrated that it belongs in either Mogollon 3 or Mogollon 4, probably the latter, which removes any necessity for further consideration here.

In his report on Starkweather ruin Nesbitt (1938: 86–8) assigned four pit houses to the Georgetown phase. Their ceramic complexes included Alma Plain (Haury 1936a: 32–4), San Francisco Red (Haury 1936a: 28–31), and "textured types," the latter including, in other contexts at least, Alma Neck Banded. Of the textured types in these Georgetown phase houses there were two sherds in each of two pit houses, four sherds in the third, and none in the fourth. This represents floor pottery only, and the chances that any of these textured sherds were Alma Neck Banded are slim considering the fact that the group of textured types (Nesbitt 1938: 78–9) also included Alma Incised (Haury 1936a: 40), Alma Scored (Haury 1936a: 38), and Alma Punched (Haury 1936a: 39), and considering also the fact that Nesbitt (1938: 138) specifically assigned Alma Neck Banded to the San Francisco phase. The published evidence from Starkweather ruin, therefore, contributes nothing in clear support of a Georgetown phase beginning for Alma Neck Banded.

The SU site can contribute little to the main problem, since its occupation was confined primarily to the Pine Lawn phase of early Mogollon 1 with a brief occupation during Mogollon 4 (Three Circle phase). It should be noted, however, that from 24 pit houses excavated and assigned to the Pine Lawn phase, the only pottery types represented were Alma Rough (Martin 1943: 238), Alma Plain, and San Francisco Red (Martin 1940, 1943; Martin and Rinaldo 1947). Alma Neck Banded was not represented in the Pine Lawn phase context. Of further interest is the fact that, since neither Georgetown nor San Francisco phase occupations were represented at the site, the occurrence of Alma Neck Banded on the floors of Three Circle phase houses (Martin 1940: 83–4; Martin and Rinaldo 1947: 369–74) clearly indicates that this type of pottery survived into the Three Circle phase of Mogollon 4.

At the Promontory site, in which four pit houses representative of the Pine Lawn phase were excavated and one other was trenched (Martin, Rinaldo, and Antevs 1949: 82–101, 184), the ceramic complex consisted of Alma Plain, Alma Rough, and San Francisco Red, while Alma Neck Banded again was not represented in a Pine Lawn phase context.

A single pit house, G, was assigned to the "Georgetown?" phase at the Turkey Foot Ridge site (Martin and Rinaldo 1950a: 268, 381). That the question in phase identification may have been due more to the absence of textured pottery from the floor than to the presence of a single sherd of Mangas Black-on-white on the floor is indicated by a reference to the former situation (Martin and Rinaldo 1950a: 360) and no mention at all of the

latter. Other floor sherds from this pit house included only Alma Plain and San Francisco Red. In the trench and fill of this structure two sherds of Mogollon Red-on-brown (Haury 1936a: 10–7; Martin and Rinaldo 1950a: 362–8) and one of Three Circle Red-on-white (Haury 1936a: 18–21; Martin and Rinaldo 1950a: 362–7), the remainder of the sherd count consisting of Alma Plain, Alma Rough, and San Francisco Red (Martin and Rinaldo 1950a: 381). While Turkey Foot Ridge is another instance of a mixed site, its Pit House G provides an example of a Georgetown phase house in such a context in which there was not a single sherd of Alma Neck Banded in either fill or floor sherds.

In Three Pines Pueblo a single pit house was assigned to the Pine Lawn phase on the basis of the ceramic complex in a sealed pit in the floor (Martin and Rinaldo 1950b: 438). This structure was adjacent to a much later Reserve phase pueblo and was used as a trash pit by the inhabitants of the latter. So disturbed was this trash deposit, probably during accumulation, that most of the later sherd types occurred on the floor of the pit house and even in another, unsealed pit in the floor (Martin and Rinaldo 1950b: 554). The sealed pit contained only Alma Plain and San Francisco Red, with a total of 113 sherds of both. While this is far from a situation capable of shedding much light on the problem at hand, the phase assignment of the pit house may be correct.

Tularosa Cave produced levels assigned on the basis of ceramics to the Pine Lawn and Georgetown phases of Mogollon 1 and 2 (Martin and others 1952: 56–8). The Georgetown phase assignments were made because those levels contained Alma Neck Banded and in spite of the fact that they also contained sherds of Mogollon Red-on-brown, a San Francisco phase diagnostic, and sherds of still later pottery types. Thus, these levels may have been incorrectly classified (Wheat 1955: 183) or they may have reflected considerable admixture from pot hunting or from other types of activity. In any event, this situation can hardly be taken as concrete evidence of the manufacture of Alma Neck Banded in a Georgetown phase horizon.

At Cordova Cave only three time horizons were recognized: Prepottery, Plain Ware, and Late horizons (Martin and others 1952: 79). The Plain Ware horizon was dated about A.D. 1 to 700 and would thus be roughly equivalent to Mogollon 1 and Mogollon 2 combined (Wheat 1955: 185). The ceramic complex of this Plain Ware horizon consisted of Alma Plain, Alma Rough, and San Francisco Red. Certain pottery types, whose life span was encompassed by the length of occupation represented at Cordova Cave, were not present in the cave at all. Those mentioned specifically by the authors are Georgetown and San Francisco phase types: Alma Scored, Alma Incised, San Lorenzo Red-on-brown (Haury 1936a: 6–9), and Mogollon Red-on-brown (Martin and others 1952: 79). Alma Neck Banded, although not mentioned in this list as being absent, is not listed in the detailed sherd analysis of Cordova Cave (Martin and others 1952: 94–101). In terms of the present problem the significance of Tularosa and Cordova caves appears to lie primarily in reinforcement of the ceramic complex of the Pine Lawn phase: Alma Rough, Alma Plain, and San Francisco Red, and no other pottery types.

In O–Block Cave several levels were assigned to the Pine Lawn phase (Martin, Rinaldo, and Bluhm 1954: 70). The sherd counts from these levels, however, are somewhat less than diagnostic (Martin, Rinaldo, and Bluhm 1954: 80–4), and these excavations contribute nothing to our problem. It is in this report, however, that the authors state quite briefly and without elaboration that "Painted and textured wares do not occur" in the Pine Lawn phase (Martin, Rinaldo, and Bluhm 1954: 64).

This completes the roster of excavated sites exhibiting Mogollon 1 and Mogollon 2 horizons in the Pine Lawn and Mimbres areas for which published information is available. These areas, either one or both but usually the Mimbres, are generally considered as the "home" of Alma Neck Banded in the southwestern United States. The foregoing analysis of the published data from these areas has brought forth nothing to support Mogollon 1 or Mogollon 2 beginnings for Alma Neck Banded. It remains now to consider Mogollon 1 and 2 horizons in other regions of the Mogollon culture.

The Hilltop phase at the Bluff site (Haury and Sayles 1947) represents late Mogollon 1 in the Forestdale Valley of east central Arizona. The ceramic complex at this site included Alma Plain, Woodruff Smudged (Colton and Hargrave 1937: 59–60), Adamana Brown (Mera 1934: 4–5; Wendorf 1953: 47–9), Gila Plain (Gladwin and others 1937: 205–11), and a single Hohokam red-on-buff sherd from high in the fill of House 3 (Haury and Sayles 1947: 57, 82). Representing Mogollon 2, the Cottonwood phase ceramic complex at the Bluff site included Alma Plain, Forestdale Smudged (Haury 1940: 73–5), Woodruff Red (Colton and Hargrave 1937: 58–9), Adamana Brown, Gila Plain, and three sherds of a variety of Lino Gray (Haury and Sayles 1947: 56, 83–4). Textured wares of any type were absent from both phases represented at the Bluff site. Perhaps it should be mentioned that Alma Neck Banded appeared as trade ware in the Forestdale phase at the Bear Ruin in the Forestdale Valley (Haury 1940: 82–3), but this is a Mogollon 3 context.

In the Point of Pines area pit houses at Crooked Ridge Village assigned to the early Circle Prairie phase of Mogollon 1 and the late Circle Prairie phase of Mogollon 2 produced no sherds of Alma Neck Banded (Wheat 1954: 176–80). The only Mogollon textured pottery represented at this site was Alma Incised and Alma Scored.

At Cave Creek and at San Simon Village in southeastern Arizona early Mogollon 1 is represented by the Peñasco phase, the earliest ceramic phase of the region and the latest phase represented at Cave Creek. At San Simon Village late Mogollon 1 and Mogollon 2 are represented by the Dos Cabezas and Pinaleño phases, respectively. Textured wares, apparently including only Alma Incised and Alma Scored (Sayles 1945, Pl. 29) were said to be present in all phases except Peñasco (Sayles 1945: 36), while Three Circle Neck Corrugated, regarded as intrusive from the Mimbres area, was confined to Cerros and Encinas phase contexts (Sayles 1945: 57) of Mogollon

4 and Mogollon 5. In view of the fact that it is neither mentioned nor illustrated, Alma Neck Banded apparently was not represented at these sites at all.

A single sherd described as "Incipient coiling on neck of polished plain ware" (Sayles 1945, Pl. 12 *e*) was present in the Peñasco phase at Cave Creek. This sherd cannot be attributed to a later phase at this site, since Cave Creek was not occupied after the Peñasco phase. It should also be noted that this is the only sherd suggesting neck banding in the entire known history of the San Simon branch of the Mogollon, excepting the intrusive Three Circle Neck Corrugated sherds of the later periods. This sherd was not, in other words, representative of a technique ancestral to a local development of the neck banding iden. Therefore, this sherd should be regarded either as peculiar without antecedent and without contributing to the development of a new idea, or as a copy of something alien to the potters of the region which did not stimulate further local interest. If the latter be the case, the source of this neck banding idea so foreign to the potters of the San Simon branch was not, apparently, in the other known Mogollon regions of the American Southwest, but the stimulus probably came from the south or east. Alma Neck Banded is now known from Chihuahua (Lister 1958: 70, 76) but so far only in a late Mogollon 3–Mogollon 4 context (Lister 1958: 113). Although the neck-banding technique may not have been native to any Mogollon area in Arizona or New Mexico known through scientific excavation, it may well have appeared relatively early elsewhere without being introduced to or accepted by the Mogollon potters of Arizona and New Mexico until Mogollon 3.

At the Cerro Colorado site near Quemado in west central New Mexico, Alma Neck Banded occurred first in a late Basketmaker III context, Ceramic Period B, which is roughly equivalent to the White Mound phase (Gladwin 1945: 38–40) and which can be correlated with early Mogollon 3 (Wasley 1959: 63–4, 170, 181–3). Kana-a Gray, the early Anasazi neck-banded product, was not represented at Cerro Colorado during this period. While this suggests the possibility that Alma Neck Banded may have appeared in the Southwest before Kana-a Gray, this evidence is not convincing because Ceramic Period B was very poorly represented at Cerro Colorado and because the site itself is entirely peripheral to the main Anasazi development.

The published evidence from White Mound Village (Gladwin 1945) makes it unclear whether Kana-a Gray occurred in White Mound phase contexts. New evidence (Wasley 1960) from excavation in a White Mound phase site without any Pueblo I occupation, between Lupton, Arizona, and the White Mound Village, shows that none of the Pueblo I pottery types, including Kana-a Gray, are represented in the White Mound phase. This again would suggest the possibility that Alma Neck Banded may have appeared before Kana-a Gray.

The foregoing discussions have brought out several points concerning Alma Neck Banded which ought to be emphasized. There is no clear evidence that Alma Neck Banded was being made in Arizona or New Mexico prior to the beginning of Mogollon 3. Based as it is on evidence that is largely negative in character, this statement should be taken as a revised working hypothesis rather than as established fact. Alma Neck Banded survived into the early part of Mogollon 4, but when this pottery type is not associated with Three Circle Neck Corrugated or Mangas Black-on-white, it may, for the present, be regarded as a horizon marker for Mogollon 3. The end date for Mogollon 3 is fairly well established at A.D. 900 on the basis of tree-ring dates and pottery cross-dating (Wheat 1955: 184–7), so that on this basis the end date for the manufacture of Alma Neck Banded may be placed around A.D. 950. The beginning date for Mogollon 3 is not so certain, but should probably be placed between A.D. 600 and 700 (Wheat 1955: 184–7), and the beginning date for the appearance of Alma Neck Banded in Arizona and New Mexico should fall within this same range. However, this uncertainty for the appearance of Alma Neck Banded leaves unsettled the Alma Neck Banded versus Kana-a Gray priority, since apparently there is not a great time difference involved.

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A POSSIBLE ANDEAN INFLUENCE IN CENTRAL MEXICO

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ABSTRACT

Stone slabs recently discovered in the region near Tejupilco in the State of Mexico are sculptured in a simple, low-relief, bold, geometric style unlike known Mesoamerican styles but with striking parallels in the Peruvian Andes.

FIG. 1 [Wicke and Bullington]. Partially buried sculptured stone at Hacienda de Guadalupe.

THE RELIEFS DESCRIBED HERE represent an art style which, to our knowledge, has never been described in the literature of Mesoamerican archaeology. Furthermore it seems impossible to associate it with any known Mesoamerican sculptural style. The isolated location of the reliefs in southwestern State of Mexico near the Guerrero border has certainly contributed to their obscurity. The area lies 12 km. south of Tejupilco, Mexico, at the Hacienda de Guadalupe (also called Hacienda de la Pancha). At the invitation of Sra. Esperanza Castillo, we visited the Hacienda in May, 1959. The surrounding zone was seen to contain a considerable number of mounds.

Figure 1 shows a stone that stood partially buried beside a mound that had been partly destroyed by treasure hunters. We were told by natives of the region that this slab was encountered along with two others like it on the facing of the mound. The latter now lie buried beneath the rubble of adobe bricks that were pulled out of the fill. The visible stone measures 126 by 96 by 20 cm. and corresponds to Type C of Figure 4. About 1.5 km. to the east a similar, though larger stone (Fig. 2) was observed lying face up on a rise of land that appeared to be a mound. It measures 161 by 124 by 43 cm. and is Type A of Figure 4. A similar slab is said to exist nearby, but we were unable to locate it.

In the town of Iztapan del Oro, some 3 km. southwest of the Hacienda de Guadalupe, three more reliefs were encountered which belong to the complex. They are now incorporated as building stones in the structure of the village church and surely must have been brought from the zone surrounding the Hacienda. The stone in Figure 3 serves as a part of a buttress of this church. It is exactly the same size as that of Figure 2 and thus belongs to Type A of Figure 4. Another corresponding to Type C of Figure 4 was noted in a wall and a stone of simpler design was also used in a buttress (Fig. 4 *b*).

Fig. 2 [Wicke and Bullington]. Sculptured stone lying face up at Hacienda de Guadalupe.

Fig. 3 [Wicke and Bullington]. Sculptured slab incorporated in a buttress of the church at Iztapan del Oro.

If we look for precolumbian parallels, nothing known from Mesoamerica offers comparison. In the Peruvian Andes, however, a somewhat similar relief style is seen. Examples are found in the Cuzco region, one in the Huarocondo Gorge (Ubbelohde-Doering 1954, Pl. 29) and another at the "*Baño de la Ñust'a*" or "Bath of the Princess" near Ollantaytambo (Bingham 1916: 445; Cassio del Pomar 1949: 160; Ubbelohde-Doering 1941: 257). In considering the possibility of Peruvian influence it

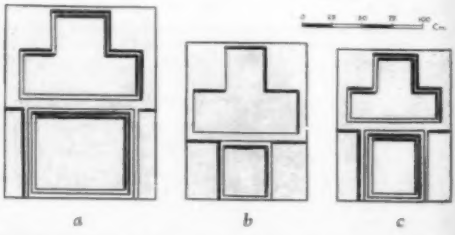

Fig. 4 [Wicke and Bullington]. Types of sculptured stone slabs. *a*, Type A; *b*, Type B; *c*, Type C.

should be kept in mind that Iztapan del Oro, Mexico, is near Placeres de Oro, Guerrero, where reliefs exhibiting the Chavín style have been found (Covarrubias 1957, Fig. 50).

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RELIABILITY OF IDENTIFICATION OF FOSSIL POLLEN AS CORN*

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ABSTRACT

On the basis of present methods of identification of corn pollen, 30% of the pollen collected from maize plants grown under a wide range of environments was misclassified as *Tripsacum* and teosinte. The results show that the characters used to describe corn pollen are too variable to permit reliable identification of fossil pollen as corn.

THE FINDING of large fossil grass pollen resembling corn pollen in archaeological and palynological sites has been of great interest to those concerned with the anthropological aspects of corn. Nevertheless, because of the great variability of size and the lack of characters to distinguish between corn pollen and pollen of certain grasses, it has long been realized that it is difficult to determine with any degree of reliability that a fossil pollen grain is corn. Some workers have used size only to identify corn pollen (Anderson 1955). Barghoorn, Wolfe, and Clisby (1954) introduced a new character for identification, the axis/pore ratio. This ratio, which represents the length (in microns) of the long axis of the pollen grain divided by the diameter (in microns) of the pore and the surrounding thickened ring or annulus, was used to differentiate pollen of *Tripsacum*, teosinte, and corn. Thus the approximate axis/pore ratios of these pollen grains are 4.0, 5.4, and 6.1, respectively. It was mainly on the basis of these ratios that Barghoorn, Wolfe, and Clisby (1954) and Clisby and Sears (1955) identified fossil pollen from Mexico City cores as that of corn. Such pollen was found to a depth of 69 to 70 m. and may be as old as the Iowan advance of the Wisconsin ice sheet. This evidence has been used by Mangelsdorf (1958) to support his conclusion that the ancestor of corn is corn and not teosinte.

There is evidence, however, which suggests only limited reliability of identification of corn pollen on the basis of the size or the axis/pore ratio. This evidence has been obtained from an analysis of pollen produced by corn plants grown under a wide range of controlled environments in the Earhart Plant Research Laboratory, California Institute of Technology (Went 1957). Corn (*Zea mays*, Bikini out-crossed) was grown in eight combinations of day and night temperatures ranging from 14° to 30° C. Four plants were grown in each of the eight environments. These plants were watered daily. Four other plants in each of the eight environments were water-stressed; that is, these plants received water and mineral nutrients only when they were severely wilted. Sufficient pollen for analysis was collected from each plant in 11 of the treatments and from three plants in two treatments. Thus pollen was collected from 13 of the 16 environments. Pollen from each plant was acetolyzed (Erdtman 1943) and mounted in glycerin jelly. Measurements, in microns, were made of the long axis and the diameter of the pore (including the annulus) of 10 pollen grains from each plant.

Various statistical analyses were made of the measurements and they will be presented elsewhere. Of particular importance here is the frequency distribution of the axis/pore ratio values for the 500 pollen grains observed (Table 1). A comparison of these values with those of Barghoorn, Wolfe, and Clisby (1954) shows approximately the same range for each set of data, but the results of the present study have a higher proportion of values in the lower range of axis/pore ratios. Statistical analysis of the two populations represented by these two

TABLE 1. FREQUENCY DISTRIBUTION OF THE AXIS/PORE RATIO OF CORN POLLEN FROM PLANTS GROWN IN THIRTEEN DIFFERENT CONTROLLED ENVIRONMENTS.

Axis/Pore Ratio	*Number of Pollen Grains*
4.8 or less	7
5.0	11
5.2	29
5.4	47
5.6	59
5.8	49
6.0	64
6.2	42
6.4	45
6.6	51
6.8	31
7.0	25
7.2	9
7.4	11
7.6	10
7.8	9
8.0 or more	1

Mean for 500 grains: 6.12

*Contribution from the Arizona Agricultural Experiment Station, Technical Paper, No. 554.

studies showed that they may be regarded as being different, with less than a one in 100 chance for these results having been due to random fluctuations. Furthermore, if the axis/pore ratios of 4.6 or less, 4.8 to 5.6, and 5.8 or more of *Tripsacum*, teosinte, and corn, respectively (Barghoorn, Wolfe, and Clisby 1954), are applied to the values of Table 1, it can be seen that seven (1.4%) pollen grains would be classified as *Tripsacum*, 146 (29.2%) grains would be classified as teosinte, and only 347 (69.4%) of the 500 grains known to be corn would be classified as corn.

By a statistical analysis of the data of Barghoorn, Wolfe, and Clisby (1954) it can be shown that of the 14 fossil pollen grains in the 69–70 m. stratum of the Mexico City core which these authors have chosen as being sufficiently well-defined to be classified as corn, four grains (28%) are below the critical axis/pore ratio of 5.7 for discriminating between teosinte and corn. Of the remaining 10 grains, only five (36%) are sufficiently large in both axis length and pore diameter as well as axis/pore ratio to be classified as corn with a high degree of reliability. Therefore, it cannot be stated unequivocally that the grass pollen grains found in the Mexico City core are corn, but there is a high probability that some of them are. It follows that the antiquity of corn cannot be established on the basis of fossil pollen with any greater reliability than the identification of the pollen.

Because relatively few, if any, fossil pollen grains resembling corn are usually found in a given sediment, it is essential that the criteria used to classify the pollen as that of corn have a very small range of variation. Only in this way can the identification be made with a high degree of reliability. The results presented here show that the axis/pore ratio has a wide range of variation and fails to describe adequately the characteristics of either fossil or modern corn pollen. Unfortunately, no more reliable character is now known, but the large probability of misclassification as a result of its use must be kept clearly in mind.

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LIFE-EXPECTANCY OF UTILITARIAN POTTERY IN TZINTZUNTZAN, MICHOACAN, MEXICO*

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ABSTRACT

Pottery life-expectancy has important archaeological implications for such problems as population sizes and duration of occupancy of sites. Specific data are here given from four contemporary Mexican village households on durability of several kinds of ware. The most important factors determining life-expectancy appear to be basic strength of the ware, functions of different types of vessels, handling practices, relative costs, and kinds of breakage. It may be inferred that similar factors determine life-expectancy in many contemporary and archaeological communities.

HOW LONG DOES A POT LAST, on the average, in primitive and peasant communities? Six months? A year? Ten years? How many pots does the average housewife in such communities have in her kitchen? Ten? Twenty-five? A hundred? The archaeologist is unable to answer these questions for the villages he excavates, for there is no known way to tell how long a sherd served as a part of a functioning vessel before accident overtook it, nor how many siblings the vessel had as of a given date. Yet if it were possible to assign an average life to the pottery remnants of a particular archaeological site, and if it were possible to estimate the average number of pots in a kitchen, the total sherd count at any period would permit calculation both of population size and duration of occupancy.

The pottery and pottery uses of contemporary primitive and peasant communities give data which are applicable to this problem. It is not unreasonable to assume that the factors that determine pottery use and pottery life today also functioned in similar communities in earlier periods, so that if these factors are recognized and their effect known, archaeological interpretation will be facilitated. The data and ideas here presented are a first step in this direction. They stem from research in Tzintzuntzan, Michoacán, Mexico, during the summer of 1959. Tzintzuntzan is a peasant community of about 1700 inhabitants on the shores of Lake Pátzcuaro, 250 miles west of Mexico City. The manufacture of pottery on a home workshop basis, for local consumption and

* My colleague, Robert F. Heizer, stimulated me to make the observations here recorded. Some of the kinds of problems he had in mind are discussed in Baumhoff and Heizer 1959.

export over a wide trade area, is the most important occupation of the villagers.

The mode of manufacture of Tzintzuntzan pottery has been described in detail (Foster 1948: 79–101). Briefly, a "red" and a "white" earth are pulverized and mixed dry in approximately equal quantities, moistened to form the paste, and shaped in or over molds. No temper is added. Neither the wheel, nor the simpler methods of coiling or shaping from a single lump of clay are used. Vessels are fired in the primitive circular Mediterranean kiln, introduced by the Spaniards shortly after the Conquest. Most vessels subsequently receive a lead glaze — also a Spanish introduction — and are refired at a temperature of about 900° C. This technique produces a relatively sturdy and durable ware, as compared to unglazed pottery fired without a kiln.

As in most of rural Mexico (and in many city homes as well), the iron age has had little influence in the kitchen: pottery vessels serve to carry and store water, to cook, and as eating and drinking receptacles. With increasing frequence a visitor finds a few glasses and porcelain plates in kitchens, but the bulk of the kitchen economy is based on locally-made pottery which comes in a bewildering variety of named forms and sizes (Foster 1948: 85).

In this article I report on observations in four kitchens, which reveal something about the range of forms and uses of pottery vessels, the numbers found at a given time, life-expectancies of various types, and the factors that cause breakage. Then I summarize the evidence and suggest its applicability to archaeological work. Two of the housewives — Otilia Zavala and Carmen Peña — are potters, who work with their husbands. The other housewives — Micaela Gonzáles (in whose home I lived) and Concepción Tzinhzún — buy or receive as gifts all of their ware.

Otilia Zavala. Otilia cooks on a large, square waist-high *chimenea* with three places for small fires so that several dishes may cook at the same time. Her kitchen has an earth floor. She estimates that eight medium-size, well-blackened cooking pots in daily use range in age from four months to one year. A large casserole, not in daily use, is about five years old, and two smaller casseroles are six months old. About 20 assorted pieces — plates, bowls, pitchers — rest on wooden shelves along one wall; these range from one to five years in age. It is difficult to know exactly, says Otilia, since when one breaks it may be replaced from current production, almost without thought. Above the shelves 33 cups (*boleros*) hang on the adobe wall. Most of these are about ten years old, made and hung shortly after she and her husband moved into this house 12 years earlier. They are used mostly for fiestas and large gatherings. Two big unglazed *tinaja* water jars rest on a raised adobe bench against one wall; these are accurately dated at 12 years, since they were set up when the family moved into this house. Otilia estimates that a cooking vessel in daily use has a life-expectancy of approximately one year. There are about 75 pottery vessels of all kinds in this kitchen. With the exception of a couple of gifts, all were made by Otilia and her husband.

Micaela González. Micaela and her grown daughters also cook on a raised *chimenea*, and on an oil stove. The small but efficient kitchen has a tile floor. The work of ten different local potters is represented in this kitchen, the accretions of gifts and purchases, the latter made particularly at the time of major fiestas when guests may be expected. A year ago Micaela bought a number of new cooking vessels, and these are the ones principally used at the time of observation. Thus, the milk-boiling pot, the bean pot, the pot for making *nixtamal*, and a frequently-used small casserole are all a year old. A second casserole is eight months old. The unglazed water *tinaja*, protected in a wooden frame beneath a filter, is two years old, and should last indefinitely. She recalls a *tinaja*, in another house, which rested on a raised adobe bench against a wall, which lasted, we calculated, more than 22 years; a wandering pig finally bumped into it. The oldest *cántaro* (for carrying water) was acquired four years ago. A large casserole, used only for fiestas, is eight years old. Micaela independently gave the same estimate as Otilia for the life-expectancy of a cooking vessel in daily use: one year. This kitchen has about 60 pottery vessels of all kinds (this figure does not include numerous flowerpots, found in all Tzintzuntzan homes).

Carmen Peña. Carmen cooks on a low *chimenea* raised less than a foot off the earth floor, and hence pottery is more exposed to wandering animals and children than in the other homes described. Of the cooking vessels in daily use one casserole is two years old, a second six months and a third three months. Five well-blackened cooking pots were acquired during the Fiesta of Nuestro Señor del Rescate in February — the time of year when most new pottery is acquired — and hence are six months old. A variety of small cooking pots range from brand new to 2½ years old. The *tinaja* is six months old, as is the *comal* (griddle for tortillas). An enormous *olla de a 2 reales*, used for making the hominy-like *pozole* of fiestas, and with a capacity of 45 liters, is the oldest vessel recorded any place. It was acquired by her husband's grandfather, when he was *carguero* (*mayordomo* in the more common Latin American terminology) between 40 and 50 years ago. Her kitchen has a total of perhaps 50 pottery objects.

Concepción Tzintzún. This kitchen, with fine *chimenea*, a hood for smoke, tile floor and plastered walls, and large glass windows, is the most modern of the four described. Although data are incomplete, two casseroles in daily use are about 18 months and three years old respectively. Two small cups for drinking chocolate are a year old, and two dinner plates of ornamental *loza negra* and *loza blanca* are about six months old. The *tinaja* under the water filter is about five years old. Other pottery pieces not in daily use are estimated at from one month to six or seven years old. Concha

estimates the average life of pottery, types not specified, at four to five years, a figure which seems to me to be disproportionately high. However, it may be noted (see below) that few children and animals have access to this kitchen.

If the data here presented are examined in the light of our knowledge of the productive process and the quality of Tzintzuntzan ware, at least four types of factors — and perhaps five — may be noted that affect the life-expectancy of pottery vessels. These factors, while induced from the Tzintzuntzan picture, certainly are true for most if not all pottery-using groups.

1. *Basic strength.* Pottery life varies directly with the hardness of the ware. Tzintzuntzan informants agree that, although there are differences in the quality of pottery finish, the basic strength of the product of all potters is essentially the same. That is, all are apparently equally workmanlike in selecting and mixing clays, in molding, and in firing ware. The strength of Tzintzuntzan ware, therefore, reflects the presence of a primitive kiln permitting 900° C. temperatures, and the strong lead glaze. The unglazed, burnished *tinaja* ware used primarily for water jars is fired but once, and is less strong. The life-expectancy of pottery will be less in villages where lack of the kiln and lack of glaze mean a more fragile ware, other factors being equal.

2. *Pottery uses.* The kinds of uses to which pottery is put are important in determining life-expectancy. *Comales* and bean pots are used daily, and, in spite of their glaze, appear to have the shortest life of all. Casseroles, and plates and cups, also in daily use, last but little longer. *Tinaja* jars have a much longer life expectancy; their protected position more than compensates for their greater intrinsic weakness. The very large fiesta pots and casseroles have a long life-expectancy, both because they are used only a few times a year, and because they are enormously thick and strong. We are probably safe in saying that cooking and eating vessels in daily use last the shortest time (an average of a year), *tinaja* water storage jars an intermediate time, and festive cooking ware the longest time. This general sequence probably is true in most pottery-using villages, regardless of the quality of the ware.

3. *Mode of use.* By this term I refer particularly to whether cooking is done on or near the ground, on the traditional three-stone hearth or a low *chimenea*, or on a raised stove of some type. Objects that customarily are used at waist height appear to last longer than those customarily used on or near the ground. Thus, for a housewife who cooks in the traditional fashion on three stones on the ground, a group of pots from the same firing will last less long than those used by a second housewife with raised stove. This is true also of water storage jars. If they are enclosed within a frame or raised on an adobe bench they last longer than if they are simply propped in a corner. To the extent that archaeological excavations reveal the mode of use of pottery we can hypothesize that — other factors constant — life-expectancy will be similar to, superior to, or inferior to that of Tzintzuntzan, depending on how favorable circumstances are.

4. *Causes of breakage.* The most common threats to pottery longevity appear to be the housewife's carelessness, the fumblings and blunderings of children, and the presence of domestic animals in the kitchen, probably in the order given. Since the first two causes must be more or less constant in most societies, the presence or absence of animals, in conjunction with other factors, is the variable to be noted. In Tzintzuntzan a surprising amount of breakage results from cats, chickens, dogs, and pigs bumping pots or knocking them over. Since only a cat usually climbs, the raised stove offers a great safety factor over an otherwise identical situation, with ground level cooking. From the standpoint of archaeological interpretation, we can assume that in those cultures with numerous domestic animals (the Old World) life-expectancy — assuming other factors always remain constant — will be less than in cultures with few or no domestic animals (the New World).

5. *Pottery costs.* The foregoing four factors influencing pottery life-expectancy are directly observable. The fifth, pottery costs, is logical, but can be proved only on the basis of comparative study. Pottery is inexpensive in Tzintzuntzan. Even for those who are not potters, it does not represent a significant item in the yearly budget. I have never heard dismay expressed when a common pot was broken, and there appears never to be a problem about replacement. The fact that pottery is so easily obtained may lead to carelessness in its use. Perhaps in villages where it is more costly greater care is taken of it, so that technically-inferior vessels last longer than would be the case in Tzintzuntzan.

For the guidance of the archaeologist who might wish to use the data given here for comparison with a site, I would suggest that the average life-expectancy of one year for vessels in daily use is longer, and the average number of pottery objects in a kitchen — 50 to 75 — is probably higher, than will be the case in most prehistoric sites. Tzintzuntzan ware, because of the kiln and glaze, is stronger than most preconquest American pottery, and preglaze Old World pottery. Again, the factors that favor long life — particularly the raised stove — are not often found in early sites. Finally, the speed and facility with which pottery is made in Tzintzuntzan is superior to any other situation known to me, except for advanced wheel-using potters, so comparatively pottery is cheap and plentiful, and can be had in quantity by nearly everybody. Although it is only a guess, I suggest that preglaze pre-kiln cooking vessels in daily use might better be calculated as having an average life of six months, rather than one year.

The data and ideas here offered are suggestive of a number of problems. Significant archaeological interpretation, however, will require much more comparative material. It would be particularly desirable to have information from contemporary communities where unglazed, open-fired, tempered-paste pottery made by the coiling and other primitive techniques is utilized.

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ASSOCIATION OF FOSSIL FAUNA AND ARTIFACTS OF THE SULPHUR SPRING STAGE, COCHISE CULTURE

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ABSTRACT

The validity of the association of extinct faunal remains with the artifact assemblage of the Sulphur Spring horizon of the Cochise culture has recently been questioned. Charred bones, bone articulation, the stratigraphic position of some of the bones above the culture bearing layer, and the frequency of association are cited as convincing evidence that the people of the Sulphur Spring horizon knew and hunted animals now extinct.

IN 1926 THE LATE BYRON CUMMINGS and a group of students removed a nearly complete mammoth skull from the south bank of Whitewater Draw, near the Double Adobe school house, Cochise County, Arizona. During the excavations stone implements were observed to be weathering out of a sand and gravel stratum below the bed in which the mammoth remains lay. Limited digging in the sand and gravel layer produced fossil bones representing horse, bison, and mammoth.

This discovery was reported verbally by Cummings in 1927 before the Southwestern divisional meeting of the American Association for the Advancement of Science and in print in 1928. The information was later incorporated in the study of the area by Sayles and Antevs (1941). At the time the latter report was issued, six localities of Sulphur Spring age were listed as well as an equal number of fossil localities in beds overlying the sand and gravel culture-bearing layer (Sayles and Antevs 1941: 11–12). The fauna in these stations included horse, bison, dire wolf, and mammoth as extinct animals and pronghorn antelope and coyote as surviving forms. These bones were not waterworn though in a matrix that was water-deposited. Since 1941, other artifact-producing localities of the same age have been discovered and the bones of camel have been added to the inventory. These will be reported in a forthcoming synthesis of the Cochise culture by Sayles and others.

This note has been inspired by the recently raised question as to the validity of the association of the fossil remains and the artifacts of the Sulphur Spring stage. Willey and Phillips (1958: 91) note this in their excellent continent-wide synthesis of American prehistory and the same doubt is expressed by Kelley (1959: 279). As one of several who participated in the 1926 excavation of the mammoth and who removed a horse jaw amidst artifacts in the deeper layer, as well as numerous bones in later years from the same layer, I feel obliged to try to answer the question voiced and to stave off the rejection of what I regard to be valid evidence.

Kelley's reason for suspecting the association of Sulphur Spring stage artifacts and fauna to be false is based on the belief that the tools and bones were of unequal age but brought together by secondary deposition in a time of alluviation. It is true that much of the fossil bone evidence has been of a piecemeal nature but this is generally true in early period deposits excepting some kill sites. Notwithstanding, there are four arguments that support the association as a valid one.

1. Some of the bones are charred and split, a fairly certain clue that the animals were a source of food. The tool-producing deposits have some of the earmarks of camp debris, that is, broken and discarded tools, numerous grinding stones, hearth stones, and scattered charcoal. The only food refuse that would survive is fragmentary bone, an expectable accompaniment of the tools, especially since these are not kill sites. The much-emphasized gathering economy of the oldest Cochise people cannot be taken to mean that they were strictly vegetarians. Steak was as succulent to them as it was to hunters.

2. Some bones have been found in normal articular relationship, for example, camel, a short distance west of the original mammoth discovery. Secondary deposition cannot be this capricious.

3. The mammoth skull was *above* the tool-producing layer and while in the initial excavation only the skull, minus the lower jaw, was found, other elements of the animal have been observed as the result of more recent weathering within a few meters of the skull. This represents a scattering of bone of the same order as seen in the Naco mammoth (Haury, Antevs, and Lance 1953). The Double Adobe mammoth must have died *after* the artifact layer was already covered by alluvial deposits.

4. Too many cases of fossil bone and artifact associations have been noted, stretching over a lateral distance of some miles, to attribute all of these to the vagaries of nature.

Looking at the problem from another angle, that of time, some additional light may be shed upon it. Differences of opinion exist about the age of the Sulphur Spring stage and the time of extinction of the late Pleistocene megafauna. Antevs (1959: 34), for example, holds that extinction came during the Datil Drought, about 12,000 to 10,800 years B.P., and that both the mammoth and the artifacts at Double Adobe are 13,000 or more years old. In contrast to this view are the radiocarbon dates of about 6200 to 8200 B.P. (Libby 1955: 112–3; Wise and Shutler 1958: 74) for the Sulphur Spring stage, or just before the Altithermal Drought from

7000 to 5000 B.P. If we take these dates at face value, which Antevs does not, and assume that the Double Adobe mammoth remains are approximately where the animal died, then mammoth were still extant by 7000 to 8000 years ago. This would have been the onset of the Altithermal Drought which undoubtedly sealed the doom of the larger animals. Lance (1959) subscribes to this view.

Despite these differing views concerning extinction, neither Antevs nor Lance question the contemporaneity of fauna and man during the Sulphur Spring horizon. It is apparent to me that the evidence for this is as good in the Whitewater Draw as it is for some of the early man sites, the Blackwater station to mention one. A factor which perhaps makes acceptance of the association more difficult in the case of Sulphur Spring stage is because the tool inventory is largely grinding stones and not fluted points. Perhaps we have come to believe erroneously that mammoth automatically spells Clovis or some other related types of projectile points.

Another stumbling block to the easy acceptance of the Sulphur Spring–fossil fauna association is the evidence from Danger Cave (Jennings 1957). Despite the early dates, in the order of 11,000 years B.P. for the oldest horizon of Danger Cave, no associated fossil remains were recovered. The culture type, called the Desert culture, is broadly enough defined to include the Cochise. Hence, the argument might run that if Danger Cave produced no fossil remains at 11,000 years ago with an associated gathering economy, it is unlikely that extinct animals were correlatives of the Sulphur Spring culture level at 8000 years ago. I do not believe that this line of reasoning should be applied here. It does not take into account the probable differential survival of the old fauna as a response to variable environmental conditions as well as the fact that regional contrasts in cultural development are demonstrable. Big game hunting seems never to have been as important in the Great Basin as it was to the east and south.

To be skeptical of the extinct fauna–Sulphur Spring stage association in southeastern Arizona is healthy; but to reject the evidence we have for the oldest Cochise culture horizon and not apply the same strictures elsewhere is not healthy. The data already available to us in the literature and personal acquaintance with the field conditions convince me that the oldest Cochise gatherers not only knew the late Pleistocene fauna but that they also relished balancing their diet with mammoth protein.

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1928 Cochise of Yesterday. *Arizona Old and New*, Vol. 1, No. 4, pp. 9-10, 26-8. The Arizona Museum, Phoenix.

Antevs, Ernst
1959 Geological Age of the Lehner Mammoth Site. *American Antiquity*, Vol. 25, No. 1, pp. 31-4. Salt Lake City.

Haury, E. W., Ernst Antevs, and J. F. Lance
1953 Artifacts with Mammoth Remains, Naco, Arizona. *American Antiquity*, Vol. 19, No. 1, pp. 1-24. Salt Lake City.

Jennings, J. D.
1957 Danger Cave. *Memoirs of the Society for American Archaeology*, No. 14. Salt Lake City.

Kelley, J. C.
1959 The Desert Cultures and the Balcones Phase: Archaic Manifestations in the Southwest and Texas. *American Antiquity*, Vol. 24, No. 3, pp. 276-88. Salt Lake City.

Lance, J. F.
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Libby, W. F.
1955 *Radiocarbon Dating*, 2nd edition. University of Chicago Press, Chicago.

Sayles, E. B. and Ernst Antevs
1941 The Cochise Culture. *Medallion Papers*, No. 29. Gila Pueblo, Globe.

Willey, G. R. and Philip Phillips
1958 *Method and Theory in American Archaeology*. University of Chicago Press, Chicago.

Wise, E. N. and Dick Shutler, Jr.
1958 University of Arizona Radiocarbon Dates. *Science*, Vol. 127, No. 3289, pp. 72-3. Washington.

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October, 1959

REVIEWS

Edited by Donald Collier

The Archaeologist at Work: A Source Book in Archaeological Method and Interpretation. Edited by Robert F. Heizer. Harper and Brothers, New York, 1959. xiv+520 pp., 99 figs., 18 tables. $8.00.

This is a series of articles selected from ancient, recent, and modern publications. The volume is divided into 13 sections entitled: 1, Reconstruction of Specific Events; 2, Restoration; 3, Reconstruction of Life and Customs; 4, Reconstruction of Houses; 5, Prehistoric Ecology; 6, Population; 7, Survey and Site Recognition; 8, Stratigraphy and Stratification; 9, Age-Dating by Rate of Accumulation; 10, Cross-Dating; 11, Seriation; 12, Lithic and Metallic Sources; 13, Art. There are 72 reprinted articles in these sections of which I had previously read less than half. Fifty-one of the articles are by American writers, 16 by British, three by Danish, one Norwegian, and one Russian.

Introductory statements preceding each section serve as a valuable commentary and other annotations point out the historic significance and value of an article. The selections were wisely chosen and reflect the wide variety of methods, techniques, and attitudes among contemporary American archaeologists, and one can compare these with the articles prepared by European scholars. The emphasis is upon archaeological field techniques and the interpretation of the field data. There is thus a large area of archaeological work which is not covered in this volume.

There is little point in questioning the wisdom of the group of students, who, along with Heizer, read, evaluated, and selected the articles presented here. The volume is, I think, a reflection of a high quality of instruction in which advanced students are allowed to feel that they are learning and evaluating with their instructor. There is even an article by D. H. Lawrence on his reaction to Etruscan tombs in which he affirms his principle, "and a warning forever against thinking how things ought to be, when already they are quite perfectly what they are."

The articles in this volume, with a few exceptions, were written as archaeological reports. In other words, they were meant to be read by archaeologists and other trained students with an interest in the data and observations of prehistory. The volume is thus not a text for an introductory course, but is extremely valuable for supplementary reading. It can be used to advantage in a course in archaeological method and theory; as an indication to non-professionals of the quality and attitudes of professional prehistorians; and as an introduction to culture history for social anthropologists and other social scientists.

The published articles and the cited bibliography are valuable leads to further study of the topics presented. The group might have presented the bibliography in sections corresponding to the content headings and listed there significant papers which would have been of value for further reading.

On page 238, the view is expressed that Harrington in 1924 was aware of the principle of superposition and that "this was undoubtedly because of his knowledge of the stratigraphic work of Nelson at the Tano Ruins in New Mexico," as well as his own work in the Ozarks. While Harrington no doubt benefited from Nelson's study he was aware of superposition by at least 1900 to 1910 as demonstrated by his work around New York City. So also were Putnam, Holmes, and others.

In addition, I should like to congratulate the publishers who have issued a volume which is not likely to produce much profit. While not arguing for censorship, I agree with Wauchope's recent complaint that American commercial publishers are not selective enough in the books on archaeology that are presented to the public.

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Evolution and Anthropology: A Centennial Appraisal. Articles by E. Mayr, T. D. Stewart, J. S. Weiner, A. I. Hallowell, J. H. Greenberg, R. J. Braidwood (Archeology and the Evolutionary Theory), W. G. Haag (The Status of Evolutionary Theory in American Archeology), L. A. White, G. P. Murdock, C. Kluckhohn (The Role of Evolutionary Thought in Anthropology). Anthropological Society of Washington, 1959. viii+172 pp. $1.50.

The ten papers contained in this volume are, without exception, excellent surveys of the impact of Darwinian evolutionary theory upon anthropology as it took form as a composite cultural-biological discipline, and of current theories of cultural evolution. I comment here only on the articles by Braidwood, Haag, and Kluckhohn, since these are most directly relevant to archaeology. Braidwood (a man who practices what he recommends) defines archaeology as "the whole anthropology of extinct cultures" and argues for the broadest possible attack by archaeology "from the biological to the cultural end of the spectrum." His article reviews the development of archaeology before and after Darwin, takes issue with the older period-sequence terminologies of Pleistocene archaeology which he feels are imprecise and lead to error, and finds that the new archaeology has broken with the old unilinear scheme of development and is able to carry out problem-oriented excavation within a classification of subsistence types (as illustrated by the Willey and Phillips *Method and Theory* book, and the Braidwood-Reed article in *Cold Spring Harbor Symposia*, Vol. 22, 1957).

Haag (whose article on archaeology beginning on p. 9 is mistitled "The Status of Evolutionary Theory in American *History*," although it is titled correctly in the table of contents) has written a very penetrating review. My only comments (beyond urging all archaeologists to read it) concern those of fact. I would not agree that Nelson's Tano stratigraphic sequence demonstration went nearly unnoticed (p. 92). In the Southwest everyone after 1916 looked for stratigraphy. And by 1930, when Haag believes "Nelson's stratigraphy was still a rarely used technique," I have the impression that most excavators worthy of being called archaeologists knew of and were using the technique of level-digging.* Haag believes that American archaeological theory is trending in the direction of multilinear evolution, and that culture history seen in a historical-developmental framework is evolutionism.

Kluckhohn's article serves in part as an integration of the nine preceding papers. As a summary and stock-taking, it is neutral in position. One quotation is appropriate:

> In the universe of culture as well as in that of biology, there are both uniqueness — which is all that one may observe or measure directly — and our scientific constructs, which in the favorable case state correctly certain general but quite abstract recurrences in the phenomena. I believe that if this conception were universally grasped and accepted, many of our disputes would be forgotten. I think, for example, that White is altogether sound in maintaining that it is absurd for critics to demand that principles of cultural evolution be expected to fit minutely the details of the culture history of each and every people. There are *both* historical regularities in the cultural process *and* the unique which can be understood only in the light of the accidents of history, including the specificities of situational factors that prevailed solely at a given period and/or locality (p. 147).

Mention should be made of the extensive and useful bibliography which brings together a large number of references on this large subject which is obviously a very much alive one in its own right and not only because of the attention paid it by Childe, Steward, and White.

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Ciba Foundation Symposium on Medical Biology and Etruscan Origins. Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. Little Brown, Boston, 1959. xii+255 pp., 60 illus. $9.50.

This 50th symposium held at the British Ciba Foundation is unique in three ways: first, archaeologists, philologists, and ethnologists met not too formally with (physical) anthropologists and human geneticists (especialy serologists); second, the resulting critical review of a fountain of theories, usual enough on the university seminar level, here involved not graduate students but carefully selected experts from six nations; and third, a pharmaceutical firm's foundation recognized the importance of human biology and micro-evolution in relation to ecology and history. The archaeologists (Barnett, Bloch, Ciotti, Foti, Hencken, Neppi Modona, Riis, Strong, and Ward Perkins) were the largest group and included people trained basically in anthropology, art, or Italian history as well as those focussing on ecology or metallurgy, and so forth. The philologists, Classicists, and ethnologists (Banti, Bolelli, Bullough, Cook, Kirk, and Piganiol) provided a persistent temper in forging discussions, with their insistence on identifying or precisely tracing migrant and settled populations and outside connections of Etruria. The physical anthropologists (Barnicot, Brothwell, de Beer, Oakley, Siniscalco, Smith, and von Vacano) and geneticists (Cepellini, Harris, Lawler, Lehmann, Morganti, and Mourant) covered an equally diverse range of interests in displaying the key to the symposium: the possibility that gene frequencies of blood types or other traits can identify origins and history of a people, such as the Etruscans, known only darkly from usual written sources.

The lock which this or a similar key must fit appeared as simple in plan: Etruscan culture, like Greek, has diverse "oriental" elements from the whole Near East (R.M. Cook, A. Piganiol, L. Banti). But in design it was exceedingly complex, since the demographic background of the Etruscan cities involves great ecological diversity, with local growth from Neolithic and Bronze Age, direct continuity out of a Villanovan Iron Age culture with its Hungarian, Hallstatt, and Greek and other Mediterranean connections (H. Hencken, G. Foti, R. Bloch, U. Ciotti, A. Neppi Modona) and hence a truly checkered history both before and after the Renaissance (D. A. Bullough). In fact, the evidence for multiple migrations, such as those of Kelts, "barbarian" Roman slaves, later Ostrogoths, Byzantine garrisons, and Lombards, is so striking in post-Etruscan times that any key to the Etruscans must generalize from the people of each village or valley. Likewise the probability of separate origins for Etruscan language, culture traits, and populations, with an upper limit of the 7th (or 8th) century B.C. (J. B. Ward Perkins, H. Hencken) and the slender later continuity even in religion and language (T. Bolelli) fits this local individuality.

It is not surprising, therefore, to find Etruscan skulls and portraits not sharply distinguishable from neighboring groups of Romans, Greeks, and so forth (N. A. Barnicot, D. R. Brothwell, A. N. Modona, O. W. von Vacano) and no unified distinction of modern Tuscany from other regions of Italy in blood types or even in frequency of thalassemia or haptoglobins, despite coastal malaria (G. Morganti, R. Cepellini, M. Siniscalco, H. Harris, H. Lehmann, A. E. Mourant). In fact, the human geneticists did not shape their part of the key to the lock: their data were such examples as coincidence of thalassemia, malaria, and certain blood type excesses — low A, high O, high M, fairly high Rh (D) — in valleys as opposed to mountains of Sardinia or near Ferrara in the Po valley, as well as intriguing speculations on malarial and other selective ecological situations in relation to balanced polymorphic allels such as those of sicklemia, thalassemia. But there are no data on thalassemia in Etruria!

* See R. B. Woodbury, 1960, Nels C. Nelson and Chronological Archaeology, *American Antiquity*, Vol. 25, No. 3, pp. 400-1.

One cannot be impatient with these gaps nor with our present difficulties in determining blood types of ancient bone (being met by Oakley and Smith), nor with the lumping of truly Etruscan and Romano-Etruscan skulls, nor with the lack of postcranial skeletons, nor even with the blindness of those archaeologists who still destroy useful human bones! It was clearly an aim of the conference to develop the kinds of data needed to make the biological key fit the historical problem: skeletons for measurement, genetic analysis, and blood typing, and blood types of modern local breeding groups. The appendices on blood grouping and on osteometry which end the book are thus vital. I am myself all too familiar with these specific problems in Greece: in 20 years, with samples of about 1000 skulls and skeletons, most of the parts of a biological key are designed; but fitting it to the lock is more subtle. So also with Etruria. We all find that progress in unlocking the multiple doors of human history means personal cooperation between many experts. This Ciba symposium crystallized the necessary international friendships. Let us hope both that more such meetings will stimulate research in the human past of such areas as Iran, Greece, Israel, East Africa, Peru, or Mexico, and that more foundation support may accrue.

A striking facet of this book is the detail of each participant's data and discussions: there are no wishful generalizations and there are many examples of use of rigorous method, as in the discussion of effect of population size on micro-evolution, or the ecological and ethnic interplay in change of dialect. Hence all anthropologists, not just archaeologists, will profit from a study of the book and can use parts of the key which it offers. Its weakness is discontinuity. But its strength is the proof that experts from the most distant fields can understand and stimulate each other.

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Terms Used in Archaeology: A Short Dictionary. Christopher Trent. Philosophical Library, New York, 1959. 62 pp. $2.75.

This book, according to the author, is designed to serve as a ready reference guide for the student and interested layman. It is handy insofar as it fits neatly into one's back pocket, but one has the feeling that the title is a bit pretentious for so small a book. The content consists of some 240 entries, an almost random selection of technical terms, site names, cultural names, pottery types, architectural features, and artifact types. Approximately half of these relate to prehistoric (pre-Roman) archaeology and the other half to historic archaeology. A majority of the names and terms are European, with a marked predilection for the British Isles (excluding Ireland). The reader will look in vain for "Maglemose," "Danubian," or "Lascaux" but can readily find "Eggar Dun," "Patera," or "Devil's Ditch." New World archaeology is rather briefly covered by four terms—"Inca," "Maya," "Toltec," "Yucatan." It may be of some interest to Mesoamerican specialists that Toltec civilization originated not less than 8000 years ago and that the Toltecs were descendants of a migratory people from Mongolia.

Trent's dictionary is certainly of little value to American archaeologists or students. The British layman perhaps may find it useful, if he can afford the pound sterling required to obtain a copy.

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The March of Archaeology. C. W. Ceram. Knopf, New York, 1958. xviii+326+vi pp., 16 color pls., 306 text illus. $15.00.

The success of the nonprofessional who popularizes a subject is often a source of irritation to the students of that field, but not entirely because he accomplishes what they seldom attempt and often fail at when they do—conveying the subject to the layman in a readable and handsomely illustrated commercial publisher's volume. This irritation is in greater part due to errors and misinterpretations which are in no way necessary for popular appeal of the book. Thus, it cannot be attributed entirely to professional jealousy and pique that books like Ceram's *Gods, Graves, and Scholars* (1951) and his more recent *March of Archaeology* are not always received without reserve.

The March of Archaeology is an attractive picture-book history of a few areas and cultural periods in man's past and of some of the workers who excavated there. It impresses one as a collection of the illustrations not used in *Gods, Graves, and Scholars* strung on a thread pulled from the text of the earlier book. The result is rather like a notebook or album, and such an effect may well have been the author's intention in creating a companion volume to his earlier work. Ceram's purpose, tracing "the historical and cultural continuity that extends from Sumeria through Babylon, Assyria, Crete, Greece, and Rome down to our own times" with a "digression" (46 pages) into Middle America, is, however, somewhat defeated by the discontinuity of the presentation. The author states in his introduction that the book "is not basically a scientific but a literary work," but by thinking of archaeology in such narrow confines of time and space and omitting any mention of prehistoric periods Ceram has missed most of the plot of the development of civilization. Granted that an author must set limits; perhaps an American reader is misled by the title which in German would refer primarily to what we call "classical archaeology." The quality of coverage within the chosen bounds, however, is uneven. A story of treasure hunting, of how the loot in the museums was secured, emerges more clearly than that of cultural continuity.

The author has made no attempt to bring his material up to date or to correct inaccuracies that occurred in *Gods, Graves, and Scholars*. What was out of date and in error there is more glaringly so here seven years later. For example, in the section on Middle America the only recent work described is that of Ruz Lhuillier at Palenque. The greater part of cultural description in this section is uncritically excerpted from codices and chronicles. Ceram's ignorance of the last 30 year's work in Middle America allows him to say of the Toltec culture that "beyond its name little is known of it," and to call it "perhaps the oldest civilization of all in Middle America." The main theme of the book, archaeological work in the Mediterranean and the Near East, would have been better served without the afterthought of a New World area.

Alfred Knopf deserves continued appreciation for publishing works in anthropology acceptable to both professionals and laymen, but Ceram's volume falls pitifully short of the standards set by such Knopf titles as Ralph Linton's *The Tree of Culture* and Carleton Coon's *The Story of Man*. If the professional anthropologist can meet the literary standards of the popular press, is it too much to ask that the professional writer be competent to handle subject matter? Unfortunately standards of competence are subject to widely varying interpretations as is suggested by Ceram's closing remarks in his introduction:

> May I also, then, in this book, take my farewell *as a writer* from a subject that has fascinated me to the utmost for more than ten years, but toward which, after ten years of study, I have lost my naïveté. That my efforts have been successful and have won some recognition among professionals must not be allowed to turn a writer's head and keep him ever bound to the same theme.

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Man's Journey Through Time: A First Step in Physical and Cultural Anthropochronology. L. S. Palmer. Philosophical Library, New York, 1959. 184 pp., 55 figs., 9 tables. (First published by Hutchinson, London, 1957).

This book has as its purpose a quantitative and graphical portrayal of the evolutionary development of man. Its author, a former professor of physics at the University of Hull (Yorkshire), has prepared two sets of graphs which purport to represent successive and progressive physical and cultural changes in the course of human history in the Pleistocene. Most of the book is concerned with the anatomical and cultural evidence which afford the necessary quantitative data for the preparation of these graphs. In the former case, for the "physical development/time graph," four indices are chosen to measure erectness of posture, size of brain, and potentiality of articulate speech. In the latter case, for a "cultural development/time graph," criteria reflecting the preservable material aspects of culture are chosen to measure the number of materials utilized by man, the number of different occupations engaged in by man, and the speed at which man moved by mechanical means.

Most students of man's past, whether primarily human paleontologist or prehistoric archaeologist, would agree that such a study is both worthwhile and necessary. But few who are well acquainted with the primary data, which Palmer clearly is often not, would agree that such a study is yet feasible. The book is filled with errors, both of commission and omission, as well as numerous archaic ideas lacking any basis in modern scientific knowledge. This is true even in regard to some basic principles crucial to the author's arguments. Thus, all of the four indices employed in the "physical development/time graph" do not certainly measure the several characteristics as is claimed. For the Pleistocene, at least, the three aspects of culture measured by the author are not particularly significant or illuminating. The unqualified use of the Milankovitch time scale is completely misleading to the ordinary reader.

This book cannot be recommended and the reviewer is hard put to see why it was originally published (in its present form), much less reprinted in the United States.

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Les Céramiques Pre-Colombiennes. Henri Lehmann. Presses Universitaires de France, Paris, 1959. viii+124 pp., 60 figs., 33 pls., 1 table, 2 maps. 2000 francs.

In this small volume Lehmann bravely attempts to describe and picture New World pottery. The subject is treated in three divisions. Technology and typology are discussed in 17 pages. A total of 77 pages is devoted to the main theme, the history of ceramics in various areas and cultures. A final section deals with collectors and collections. This book is one of a series, *L'Oeil du Connaisseur*, all volumes of which are advertised at the same price. Inevitably the scope is limited, but this attractive publication contains information and illustrations that will interest many students of the subject.

A book of this type is possible only if the material discussed is rigorously selected, so the author has concentrated on "the most characteristic civilizations." Thus, in 14 pages, including 7 text figures and accompanied by 6 plates, he disposes of Argentina, Brazil, Chile, Ecuador, Venezuela, the United States and the West Indies. His main interest is in central Mexico, the Maya area, Costa Rica, Panama, Colombia, and Peru.

The principal part of the text deals with the pottery types of these regions. It is simply written and covers the major stylistic groups. The 60 text figures are line drawings, almost all of which come from previously published sources: Piña Chan and Marquina for Mexico, Lothrop for southern Central America, Bennett for western South America. The accompanying plates, however, depict pottery vessels most of which had not been previously illustrated. The majority of these are in the Musée de

l'Homme. These plates, eight in color, are a welcome contribution.

There always is a time gap between completion of a manuscript and its publication. This is reflected by the omission from the bibliography of several recent ceramic studies, such as Covarrubias on Mexico, Brainard on Yucatan, R. E. Smith on Guatemala; also Evans and Meggers, Estrada, and Reichel Dolmatoff on Brazil, Colombia, and Ecuador.

Radiocarbon dates, most of which apply to pottery, often are of a controversial nature. Nevertheless, they are a major tool in establishing chronology. Some of the recently published results from the Maya area and southern Peru suggest possible revision of Table 1. Radiocarbon dates which apply to the pottery of Panama have become available too recently to be included in this book, and their significance has not yet been fully established.

At the end of the volume there are three short sections of general interest. One deals with the question of forgeries. Another discusses the fluctuations in price of pottery vessels sold at auction in Paris between 1927 and 1958. Successive devaluations of the French franc are quoted, which makes possible comparisons with other currencies. All museum curators are questioned on the values of archaeological objects. Lehmann gives an impartial answer by recording maximum and minimum prices on such types as Nazca spouted jars, Mochica portrait vessels, Zapotec effigy urns, Tlatilco figurines, and so forth. A similar compilation of prices in the United States would be useful.

There also are several lists of pottery collections. One names 21 major museums in Europe and 12 in North America. A second records outstanding museums and private collections in the individual countries of Latin America. A third list locates various collections exemplifying specific ceramic styles.

To sum up, this book obviously is written for the general public but it contains source material of value to the specialist. The reviewer would like to see a series of volumes in similar format, each devoted to a limited area. Additional illustrations from the great collections in the Musée de l'Homme and other European museums, to which many of us do not have access, would be a valuable contribution.

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The Art of the Ancient Maya. Alfred Kidder II and Carlos Samayoa Chinchilla. Photographs by Reuben Goldberg. Thomas Y. Crowell, New York, 1959. 124 pp., 99 pls. (4 in color), map. $5.00.

This attractive volume was issued by the Detroit Institute of Arts in connection with a traveling exhibition of pre-Columbian Maya art. In addition to Detroit, the exhibit was held at the University Museum, Philadelphia; the William Rockhill Nelson Gallery of Art, Kansas City; the de Young Memorial Museum, San Francisco; and the Los Angeles County Museum. Numerous specimens from the National Museum of Archaeology and Ethnology, Guatemala, were displayed, supplemented by pieces from the University Museum and other American institutions and from private collections. There is, accordingly, a strong Guatemalan emphasis, although an intention of the exhibit, as set forth in the Foreword, was to emphasize the differences within Maya art as a whole. To accomplish this end, Maya art is divided according to five regions (Highlands, Southern Lowlands, Northern Lowlands, Atlantic Slope, Pacific Slope) and the four standard cultural periods (Preclassic, Early Classic, Late Classic, and Postclassic). With the exception of the Pacific Slope, where the materials fall outside the recognized stylistic traditions of Maya art, the regions are given approximately equal coverage. Although a "Maya" theme dominates the exhibit and publication, the Izapa-like features of a recently-discovered Preclassic stela from Kaminaljuyú (Fig. 7) deserve mention.

Chapters by Kidder and Samayoa Chinchilla are aimed for the non-specialist. Kidder's summary of Maya prehistory follows currently favored reconstructions. The florescent aspects of late Preclassic culture are emphasized, and Kidder holds to the peaceful nature of Classic Maya society, with increasing secularization during Classic times and a collapse brought about by revolt. Postclassic art, while barely discussed, is related to a universal cycle of development, florescence, and decline that characterizes all great artistic traditions. Samayoa Chinchilla's essay, in his own words, is intended to awaken a "liking and admiration" for Maya culture. In passing, it seems strange to me that the commonly accepted picture of the Classic Maya as a markedly peaceful society maintains so strong a hold. The art, at least, is replete with motifs which would seem to denote militarism. It might also prove worthwhile to reexamine the assumption, repeated here by Samayoa Chinchilla, that the conservatism of Maya art is to be explained in terms of limitations imposed on unwilling artists by the priesthood.

Illustrations, from photographs by Reuben Goldberg, are excellent. A number of the specimens, from highland Guatemala and elsewhere, are not well known, and their publication is especially welcome. Representing the approach of archaeologist and humanist, the text provides a background to Maya art that will help to guide the general reader and should provoke some thought on the part of the specialist.

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University, Miss.

Indian Art of the Americas. Donald Collier. Catalogue of an Exhibition at Chicago Natural History Museum, 1959. 64 pp., 68 illus. $1.00.

This exhibit is a splendid selection of more than 50 objects of aesthetic value such as only a great museum can draw out of its stores, supplemented by a roughly equal number of loaned masterpieces, combined in a

temporary exhibition. The Chicago museum in fact could display such an exhibit annually out of its own resources for years, each time for a new area, period, or theme, without repeating. So long as many art museums refrain from recognizing native, primitive, or non-literate art except sporadically or marginally, it is to be hoped that the great natural history museums will continue to provide such opportunities. The time may come when demarcation is wiped out.

Sixty-four pieces are figured in the catalogue, nine of them ethnographic, the remainder archaeological. The photographs are excellent — some with accentuated shadows, some shadowless. Three-fourths refer to the nuclear area, one fourth to the non-nuclear tracts of America. Of the pieces illustrated, 19 are pottery, 18 stone, 12 wood, ten metal, one each of textile, skin, horn, feathers; the distribution range is wide. No one style or region predominates: there are only three Maya, four Aztec, two Mochica, six Northwest Coast photographs. The "minor" styles are unusually well represented: Plains, Nayarit, Colima, Totonac, Zapotec, Costa Rica, sub-Taino, several Colombian centers, Río Napo, Cañete, Atacama.

Native American art achievement proves to be outstanding in the plastic round — sculptural or protosculptural modeling. Only nine pieces illustrated bear more than incidental or supplementary painting: eight of these are South American ceramics. There are about as many two-dimensional metal objects, half of them embossed, wired, or incised, half depending basically on their outline. The latter perhaps attain superior aesthetic effect because less distracted by detail. Some half-dozen relief carvings are shown, centering in southeast Mexico, but including a geometrically decorated wooden blade from Brazil, and an astonishing flat stone Calchaquí mask.

One quality previously noted for native American art is expressed by several pieces. This is "sizelessness": a miniature carving can be blown up to monumental size, or reverse, with no qualitative change of effect. This seems to involve reduction of form to its basic essentials.

The four-page text on Diversity of Indian Art (followed by Suggested Readings) is excellent and makes one wish there were more. Whatever the theme of future exhibits, the introductions to their catalogues might well be several times as long. With still longer general discussions, well-illustrated catalogues like this one would probably sell for years on their inherent attractiveness.

A. L. Kroeber
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Orfebrería prehispánica de Colombia. Estilos Tolima y Muisca. José Pérez de Barradas. Banco de la República, Museo del Oro, Bogotá, 1958. 2 vols. Text: xv+385 pp., frontis., 147 figs., 10 color pls., 1 map; Plates: 20 pp., 287 pls.

Persistent rumors that the Bank of the Republic in Bogotá has decided to abandon this indispensable publication *in medias res*, so to speak, make me feel like one called on to give evidence at an inquest.

These two fine volumes represent the third and fourth of a projected six volume *catalogue raisonné* of the fabulous collection of some 7000 examples of ancient Colombian metalwork, principally goldwork, assembled by the Museo del Oro since 1939. The establishment of that museum and the printing of this encyclopedic catalogue by a commercial banking institution are worthy of a volume in themselves, but that story must be told elsewhere. Suffice it to say that the museum and the catalogue have each received the most sincere form of flattery; they have been imitated, but not very successfully.

These volumes, as did the two earlier ones, go far beyond the ordinary requirements of a catalogue. They come closer to being a treatise on pre-Columbian metal technology than anything available today in any language. Thanks are due the Bank for having underwritten the formidable publication costs (anyone who has ever had to wrestle with a publication budget will appreciate this); and congratulations are in order all around: to the author for a comprehensive and well-written text, to those who did the off-set work and color plates, to the typographer and to the printer.

Quite appropriately these two volumes have been dedicated to the late Dr. Luís-Angel Arango, chief executive officer of the Bank at the time of his death, who was largely responsible for the establishment and growth of the Museo del Oro and entirely responsible for commissioning this catalogue. The Introduction, which merits close reading, is devoted to a philosophical discussion of "style" and its relationship to the author's method of approach.

The two styles under investigation, Tolima and Muisca (or Chibcha), are treated individually from the points of view of (a) their sources or alleged sources (the lack of adequate provenance data will always bedevil investigators in this field); (b) how the objects were made, a first-rate consideration of technology based upon visual examination with a binocular microscope; (c) typology and symbolism; and (d) their origins and relationships with other styles of Colombian prehistoric metalwork. Quantitative analyses are included for each object, a monumental undertaking and something not to be found in any other work dealing with this subject. Also included is an excellent technical review of the early metallurgy of copper, based on the works of Forbes and Oldeberg.

Finally there is a trail-blazing Appendix on "fakes," and a good bibliography. The technological sections and the Appendix, however welcome, are not without their dangers. It is not safe to be too specific about such matters lest one find himself in the position of having written a *vade mecum* for the fakers, some of whom may be quite literate.

The volume of plates contains a welcome innovation. Rear views and details of certain objects are illustrated. These are invaluable to the reader interested in metalworking techniques.

According to Russell Lynes, that light-hearted chronicler of the contemporary scene ("Mayhem in Academe," *Harper's Magazine*, June, 1954), tradition requires some peevishness or the venting of some spleen in any well-ordered review of a scholarly work by a professional scholar. Alas, that cannot be, (a) because I am not a professional scholar, and (b) because Pérez de Barradas is too much of a scholar to leave himself open to serious attack. I am troubled by his seemingly uncritical acceptance of Heine-Geldern's speculation about metalworking techniques having been imported from Asia, but that is a matter of personal opinion. Like Nordenskiöld and Bergsøe, I cannot understand why it should be felt necessary to assume that the pre-Columbian inhabitants of this hemisphere were incapable of making important discoveries in metallurgy and metalworking quite independently of Old World developments.

On pages 68–9 of the text Pérez de Barradas resurrects a little booklet by Margain, and gives it a certain undeserved *cachet* by quoting it in connection with some untenable speculation about black fracture in a Tolima piece (No. 4453, Pl. 64). Better that that booklet had been allowed to rest in peace, for seldom, if ever, has so much metallurgical nonsense been compressed into such a small space. The condition described by Pérez de Barradas, although having a superficial resemblance to carbonaceous material, is one which might more accurately be called "black core corrosion." I have seen it in both Panamanian and Colombian pieces. In any event, it has nothing to do with the presence of carbon, and has been fully explained by Bergsøe, a professional metallurigst, in his 1938 publication on the gilding process employed in Ecuador (pp. 10–12). Bergsøe relates it only to fusion gilding, but I have seen it in tumbaga pieces submitted to *mise en couleur* treatment to concentrate the gold on the surface. In fact, tumbaga provides an ideal medium for the electro-chemical process involved in the corrosion of the copper, the process being dependent on the presence of gold in the alloy. In the volumes under review Pérez de Barradas has evidenced that rare and refreshing quality of being willing to confess error, so we may look for a correction of this in some later publication. However, I feel that it is too basic to go unnoticed at this time.

Having followed the progress of the Bank's catalogue since its inception over six years ago, and being convinced of its validity, I would like to plead personal privilege to conclude this review with an expression of hope that some way will be found to assure the publication of the projected volumes on the Quimbaya and Sinú styles. Both esthetically and technically they are by far the most interesting and important early Colombian metalwork. The Bank may, with considerable justice, feel that it has carried the laboring financial oar long enough. If so, it seems to me to be a scholarly project worthy of private or foundation support, or both.

DUDLEY T. EASBY, JR.
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Archeological Explorations in Central and South Idaho — 1958. I — Types and Distributions of Site Features and Stone Tools. E. H. SWANSON, JR., DONALD R. TUOHY, AND ALAN L. BRYAN. Occasional Papers of the Idaho State College Museum, Number 2. Pocatello, 1959. 104 pp., 19 figs., 18 maps. $1.00.

This is a difficult volume to review. Textual treatment is limited to a brief introduction and summation, totaling only slightly more than three published pages. The remainder of the volume is devoted to the description of certain varieties of stone artifacts, phrased as "types," amplified with extensive illustration and distribution plots. Site features, house pits, stone structures of various sorts, pictographs and petroglyphs are included on the distribution maps and are briefly described in the introductory statement.

The material presented here is the result of an intensive reconnaissance of a number of proposed reservoirs in the Snake River–Salmon River drainage systems. Some 650 archaeological sites were examined and more than 8000 artifacts were recovered through surface collection. Descriptions of artifacts, grouped as minimal "types" are cursive but adequate. Included for each is an indication of quantity, range of size, materials of manufacture, site provenience, presence in specific amateur collections, and brief comments upon significant characteristics.

The "types" offered by Swanson and associates are merely tentative or experimental groupings. There is a marked tendency toward "splitting" with a consequent tendency toward a proliferation of groups, which at first glance is carried almost to the point of confusion. However, this multi-type approach was carefully calculated "in an effort to see if separate distributions resulted." The distributions of artifacts, related to physiographic factors, appear to have produced useful results. Projectile point groups designated as "early" occur in forested foothill areas along the southern edge of the Salmon River mountains and in the desert areas of the Snake River plains. Tipi rings are correlated with the mountain zones, as are large house depressions, although these occur elsewhere with a much reduced frequency. In total, the largest sites, and, excepting a portion of the Snake canyon, the largest number of sites fall in the foothill zone. This leads the authors to the conclusion ". . . that we need to re-examine our concepts of the Plateau, at any rate, as being plateau in character. It may be that as time goes on we will find the foothills to have been more important than the open country. Much of the character of the historic cultures may have been established in the forest zones before the beginning of the historic era."

One might question the value of minimally organized, minimally analyzed data of this sort, yet in the greater Pacific Northwest, just such an outline of basic raw material is the *sine qua non* of further synthesis. Data are scanty at best, and often markedly localized. The preliminary organization provided by Swanson and his associates lays the groundwork for intelligent, planned

excavation, and constitutes the first step in a much needed ecological attack upon problems in the Plateau.

As is too often the case, the illustrative materials are not up to the level of the remainder of the publication. All artifacts are illustrated by line drawings. In many cases they appear to be overgeneralized and careless in execution. Similarly, maps are lacking in orienting detail and are not always well reproduced. Still, it is a usable document, and more important, an essential one for the regional specialist.

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Wesen und Ordnung der altperuanischen Kulturen. Max Uhle. Edited by Gerdt Kutscher. Bibliotheca Ibero-Americana, Band 1, Ibero-Amerikanische Bibliothek, Colloquium Verlag, Berlin, 1959. 132 pp., 7 figs., portrait, 2 pls., 4 tables. DM 9.–

In the year 1917 Philip Ainsworth Means published a 93 page study entitled *A survey of ancient Peruvian art.* Since this study was mainly concerned with the chronology and interrelationships of the ancient styles then known, it came very close to offering a synthesis of Peruvian archaeology. Means was then 25 years old and had been interested in Peruvian archaeology for four years. Max Uhle was in northern Chile at the time he received a copy of Means' study; he was finishing up his research in Chile and was soon to start work in Ecuador. He was 61 years old and had begun his field work in South America the year Means was born. Although Uhle had published many articles reporting on aspects of his field work, he had not written a general synthesis of his ideas on the chronology and relationships of ancient Peruvian cultures since 1902.

Means' *Survey* stirred Uhle deeply. He found himself in disagreement with almost everything Means said, except where the younger man was following Uhle's earlier publications. The disagreement resulted partly from the fact that Uhle knew far more about Peruvian archaeology than Means could, and partly from weaknesses in Means' reasoning. Means based some very far-reaching conclusions on scraps of flimsy evidence.

Uhle's feelings were sufficiently strong so that he went to work immediately on "a critical review of the ancient Peruvian cultures as a whole" in which he discussed Means' theories in detail. The manuscript of this work was completed in 1918, but Uhle did not publish it. Very likely he intended to revise it further; he may also have been discouraged by the difficulties of publishing so substantial a work in German at the end of the first World War. The manuscript was found among Uhle's papers by his literary executor, Gerdt Kutscher, who has now published it with new illustrations, an extensive bibliography, and an index. Kutscher believes, and with some reason, that Uhle's synthesis of Peruvian archaeology after the end of his field work in Peru will be of interest to present-day Americanists.

Uhle's synthesis is, of course, 40 years old, and a tremendous amount of research has been done in Peruvian archaeology since it was written. Its publication is a contribution to the history of science rather than to current research problems. Nevertheless, one cannot help but be impressed again with how far ahead of his contemporaries Uhle was in his understanding of chronological relationships. It was more than 20 years after this work was written before the rest of us went significantly beyond the knowledge that Uhle had accumulated almost single handed. We can only regret that it was not published at the time it was written, so that it could have been used by Kroeber in his studies of Uhle's collections in the twenties.

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Cougar Mountain Cave in South Central Oregon. John Cowles. Privately published, Rainier, Oregon, 1959. 50 pp., 45 pls., 1 map. $2.00.

This small booklet is a photographic essay by an untrained amateur archaeologist, who spent 63 days in 1958 excavating a small rockshelter in the south-central Oregon desert country. The cave is 20 miles east of the Fort Rock Cave, excavated by L. S. Cressman in 1938, from which sagebrush bark sandals were dated at 9053 ±350 by radiocarbon. Cowles seems to have done a methodical job. He screened the refuse, kept records by stratigraphic levels, photographed the materials, and published the results, all at his own expense. The brief text of the report tells what he did, how he did it, and describes the specimens. The photographs, most of which are ¾-page illustrations "bled" to the page edges, are of outstanding quality and clearly show what the sandals, basketry, cordage, stone, bone, wood, and horn artifacts look like. I wish more archaeological publications could be as well illustrated. Cowles makes little attempt at interpretation other than to compare some of the material to that recovered from Fort Rock Cave. It seems to me that this is just what the untrained person should do. Anyone can readily use the data from this report.

The cave had over 6 feet of deposit, with a layer of pumice separating the lower 4 feet from the upper 2½ feet. Lanceolate points were found in the lower levels, but notched points appeared only above 2½ feet from the bottom. Perishable material was sorted by types from level to level, but bone tools were confined to the levels below pumice and bison bones to the bottom 2 feet of deposit. This is an important cave site, and Cowles' report of its excavation should be in the library of every archaeologist whose interests lie in western United States prehistory.

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Lincoln, Neb.

Stone Age on the Columbia River. EMORY STRONG. Binfords and Mort, Portland, 1959. 254 pp., 107 figs., endpaper map. $3.95.

In 1946 Binfords and Mort issued a book, *Indian Relics of the Pacific Northwest*, by N. G. Seaman. Now, 13 years later, the work under review has been published. I hope and like to think that the differences in approach to collecting and amateur archaeology expressed in these two books reflect a change in attitude and recognition of scientific values and the need for conservation among the numerous and aggressive collectors of the Northwest. If so, it bodes well for the future. There is some hope that the energy of the relic enthusiast may be guided into efforts that will be of value to regional prehistories and will be intellectually far more satisfying to the participants than the loot-and-grab, cigar-box collecting that has earned for so many of them the derisive term of pothunter. Let us hope that the spirit of the old commercial digger (p. 150) does not live on. Strong is realistic and honest about such things and points out that federal laws "did not stop many" (p. 84).

The book is not an archaeological report nor is it claimed or intended to be. Strong modestly calls himself a "relic-hunter only — one of the fast growing group who are pleased to call themselves 'amateur archaeologists.' " I have known him for several years and he belongs among the best of the latter group. He has an excellent sense of history; there is a mingling of quotes, in appropriate places, from Lewis and Clark and other early visitors to the Columbia Valley. These enliven and deepen the feeling for the area and for the sense of continuity with the past that I believe Strong wished to impart.

The book is divided into four parts. Part I, The Setting (96 pages), is devoted to a generalized description of the area, remarks and short disquisitions on its past, on aspects of Columbia ethnography and archaeology, and much more. Although often aimless in nature, this part is informative and reads and follows well. Part II, The Culture (102 pages), is an account of selected and finer or more spectacular artifacts, usually from the Lower or Middle Columbia. In spite of the fact that one will not find here the concentration and precision of data that professionals hope to achieve in their publications there is a broad sweep of description and a moderate supply of detail. The reader who is untutored in the past of the Northwest will come away with a basic feeling for the tremendous range of artistry, artisanship and skill of the men who lived and labored there. Part III, Trade Goods (36 pages), is probably the most valuable part of the book to the serious student. It is the best statement that I know for this material from the Northwest. Part IV (8 pages) is a very brief statement of digging methods, perfectly clear and conventional. It also contains the Code of Ethics and Statement of Policy of the Washington Archaeological Society; one of the best declarations of this kind that I know. It is interesting that Strong used this excerpt from the WAS instead of quoting a part of the Constitution of the Oregon Archaeological Society with which he has been identified for a long time. A short bibliography and usable index follow.

Mistakes are few and far between. Figures 33 and 42 illustrate antler rather than bone items; on page 133 one finds the statement that graphite is found no closer than Dillon, Montana. This is incorrect; there are numerous deposits in Washington. Other small errors exist, but I believe none to be serious.

There has never been a study of the artifacts that are in the vast collections up and down the Columbia. This book is the best catalogue we have showing the range of these collections. Let us hope that it will stimulate a series of studies of private collections. It is a good book with excellent illustrations and attractive format. Interested laymen will enjoy it and scholars and teachers will find it useful.

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Pottery Types of the Southwest. Ceramic Series 3D. Edited by HAROLD S. COLTON. Museum of Northern Arizona, Flagstaff, 1958. 170 pp., 50 figs., 39 maps.

Ceramic Series 3D is the sixth installment of a series of ceramic descriptions and listings of pottery types found in the Southwest. It is the plan of the editor, Harold S. Colton, to list all of the 39 wares found in the Southwest, and to bring up to date the type descriptions of all types found within these wares. The present installment includes types composing the following wares: Alameda Brown, Tizon Brown, Lower Colorado Buff, Prescott Gray, and San Francisco Mountain Gray. There is a broad description of each ware, giving its range, and more detailed revised descriptions of each type within the ware. With the publication of this material 23 of the 39 wares are now published. These descriptions are on sturdy paper, which is perforated to be arranged systematically in a loose leaf notebook for ready reference.

The present series both supplements and partly supplants previous ceramic publications of the Museum of Northern Arizona. Old descriptions have been modified and new types within wares added. With the ware descriptions there is a key to the types to facilitate rapid identification, or a listing of types is given. There are abundant illustrations, including maps showing the location of types, examples of type sherds, vessel forms, distinctive rim forms, and identifying design combinations.

To anyone seriously at work in the Southwest, and particularly those undertaking archaeological research in the plateau portion of the area, the complete series of descriptions are a necessity. There are now more than 500 different aboriginal pottery types, both ancient and modern, that have been described for the Southwest. As a result it has become impossible for any one worker to keep each of these types firmly in mind, and the re-

searcher must have some systematic key to their descriptions. The already published, and the contemplated, papers in the ceramic series will constitute an up-to-date key to and description of these many types.

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The Coombs Site. Robert H. Lister. With a chapter on pottery by Florence C. Lister. University of Utah, Anthropological Papers, No. 41, Salt Lake City, 1958. xi+114 pp., 43 figs., 14 tables. $2.75.

This report is the eighth in the University of Utah's Glen Canyon series prepared under contract with the National Park Service as a part of the Upper Colorado River Basin Salvage Program. The site is a significant one located in the small community of Boulder in southeastern Utah in an area little known archaeologically.

The 1958 excavations at this ruin carried on by the University of Colorado Archaeological Field Session under Lister's direction are presented as a "preliminary" account but in commendable detail. Parenthetically, the work provides a good example of inter-university co-operation which might be emulated with profit in neighboring states.

Following an introduction to the region Lister gives a short synopsis of his 1958 work. Exploratory trenching revealed three jacal and stone masonry structures plus a pit from which caliche had been dug. Data concerning the excavation of these units, together with plans and photographs, and tables listing pottery types from each room make up about half the report. The detailed analysis of the ceramics by Florence Lister, based largely upon microscopic examinations, is well done and constitutes a particularly valuable contribution. Other artifacts are described under simple headings of chipped and ground stone, bone and antler, vegetable fiber, and ornaments. This section could have been made more useful had the artifacts been identified as to provenience, either in description or illustration. Three fragmentary and undiagnostic burials are described last.

In conclusion, Lister remarks that his preliminary observations after excavations of one season indicate that the Coombs Site was probably occupied by peoples of the Kayenta branch of the Anasazi. The majority of the 23,668 sherds recovered belong to that culture during late Pueblo II and Pueblo III stages, from about A.D. 1075 to 1275, with a peak between 1100 and 1150. It will be of importance to learn the results of his second season's work in 1959 to see whether such a late occupation date (1275) by Pueblo peoples north of the Colorado River is substantiated. Surprisingly, very little contact with the Fremont culture was observed, while evidence of relationships with the Johnson and Virgin branches to the southwest was also limited.

In all, the Listers have presented a well-rounded and very prompt report marred by only one error of minor magnitude (a conversion from millimeters to inches on p. 79) and in some portions slight grammatical inconsistencies such as too frequent tense changes. The authors and the universities of Utah and Colorado are making a worthwhile contribution to the hitherto poorly understood archaeology of southeastern Utah.

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Engraved Shell Gorgets and Their Associations. Madeline Kneberg. Tennessee Archaeologist, Vol. 15, No. 1, pp. 1–39, Knoxville, 1959. 77 figs., 2 charts, map.

At last someone has done a long-needed job. Madeline Kneberg has arranged the various shell gorget types of eastern Tennessee into a sensible chronological sequence. She is certainly in the best position to do so, and her study is based on an analysis of 77 gorgets, all of known temporal provenience from 17 properly-excavated eastern Tennesee sites. These artifacts all belong to aspects of the Southern Cult; the first group to its period of florescence, the last two groups to its period of attenuation. All fall within the temporal phases of Dallas focus. She recognizes nine design types.

The first group consists of the Square Cross, Turkey Cocks, Eagle Dancer, Spider, and Circular Cross designs. There is evidence that the Square Cross design is early and even may possibly precede the other types. All the others equate with the apogee of the Southern Cult. In the Eagle Dancer design, she lumps three familiar subtypes, the fighting eagle being, the single eagle being, and the seated eagle being. The Turkey Cock design also includes those representations which have been elsewhere interpreted as the pileated woodpecker. The Circular Cross design seems to be late and merges into the next group. The second group, in addition to the last mentioned design, consists of the Scalloped Triskele, Conventionalized Dancer, and Rattlesnake designs. Into this group the Rattlesnake design enters late. The excised natural type apparently appears earlier than the highly conventionalized type. The third temporal group consists of the Rattlesnake and the Mask designs. The Rattlesnake design persisted up into the European contact period while the Mask design apparently dropped out.

There are some interesting age and sex associations with gorget designs. The Spider design is found exclusively with infants. The Scalloped Triskele design is found with females or infants. The Mask design is found only with males or children. Guess dates of A.D. 1000–1400, 1350–1500, and 1450–1750 are given for these three groups. An elaborate site-by-site chart of gorget types, burial types, and associated artifacts is provided as well as a simplified chart correlating gorget types and associated artifacts.

It should be realized that this gorget sequence applies only to eastern Tennessee and upper Georgia. The Georgia data, while much less complete, entirely substantiate Kneberg's main contentions. Lewis Larson's recent work at Etowah gives us a number of gorget types of the classical Southern Cult period (Kneberg's first group) and this precise position in the Etowah ceramic sequence is known. It is the Wilbanks which just precedes Lamar. Other scattered gorget finds consist chiefly of the Rattlesnake and Mask designs and appear either in a Lamar context or later. In Georgia and Tennessee, therefore, gorget design types are reliable time markers. One remarkable thing about this restricted area is the virtual identity of design. This contrasts with surrounding regions where lack of uniformity is almost the rule. I am thinking, of course, of Moundville, Spiro, and southern Missouri. Also outside of the area we are considering individual design types have different distributions — the Mask design extending northward to the Great Lakes area and the Rattlesnake eastward across the Appalachians into Virginia and the Carolinas and in Georgia to the coast. The Scalloped Triskele design so common in Tennessee is apparently restricted to Tennessee. Offhand I cannot recall an example from Georgia.

Kneberg has pointed out the temporal significance of the various gorget design types, but has left unanswered the questions of distribution.

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The Belcher Mound, A Stratified Caddoan Site in Caddo Parish, Louisiana. Clarence H. Webb. Memoirs of the Society for American Archaeology, No. 16, Salt Lake City, 1959. 212 pp., 142 figs., 4 tables. $3.00.

The Belcher Mound, located in extreme northwestern Louisiana, was one of the key sites used by Krieger in formulating his classification of the Caddo area. It was excavated by Webb and some of his friends on week-ends and for other brief periods over a considerable span of time, extending from 1936 to 1954.

It is a safe prediction that this report will rapidly be assigned a permanent niche in the library (and lab) of every person working with the archaeology of the southeastern United States. However, the report is far more than a specialist's handbook. The detailed summarizations and area-wide comparisons undertaken by Webb carry it into the realm of those reports which need to be in every library that makes any pretense toward coverage of archaeology as a subject or Southeastern prehistory as a topic.

Its utility to the specialist both as a source and as a model can be illustrated by Webb's treatment of pottery. He first discusses briefly the general styles of pottery present (engraved wares, stamped wares, plain wares, and so forth). This is followed by detailed typological descriptions which cover not only the standard aspects but which also include discussions, often lengthy, of the chronological position and distribution of the types and their relationship to other types. The pottery associated with each of his temporal divisions is summarized and discussed. Webb concludes with a comprehensive comparative analysis of the various ceramic traits present at the Belcher Mound, including in his discussion temper, shape, pigment, and decorative techniques.

The value of the report to anyone concerned in any way with the prehistory of the Southeast can be demonstrated by looking briefly at his treatment of house types. The houses at the Belcher site are described in detail. (This includes group illustrations of objects found in each house, a technique Webb also employs in his discussion of burials and one which I feel is utilized entirely too seldom. It establishes in the mind of the reader a feeling for and a grasp of a particular cultural context which can be obtained in no other way.) The descriptions of the houses are followed by six pages of summary and comparisons in which Webb outlines a development of house types not only at the Belcher site but for the entire Caddo area. These developments are then compared to those occurring in adjacent areas extending from the Southwest to the Ohio Valley. He suggests whenever possible the source and direction of influences.

In view of his extensive comparisons, particularly within the Caddo area as a whole, a map of the entire region would have been appreciated by the many readers who will not be specialists in the Caddo. The map included, while valuable, covers too limited an area. It also is unfortunate that the whole pottery vessels photographed, unlike nearly all other objects, were not identified by catalogue number to permit ready cross reference. This comment is in itself something of a back-handed compliment for the absence of identification is notable principally because with this small exception the author has done a truly outstanding job of illustrating and cross referencing his materials.

This report sets a standard which part-time archaeologists and full-time professionals alike can strive for and emulate.

Charles R. McGimsey III
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American Indian Ways of Life, An Interpretation of the Archaeology of Illinois and Adjoining Areas. Thorne Deuel. Illinois State Museum, Story of Illinois Series, No. 9, Springfield, 1958. 76 pp., 38 figs., 3 tables. $0.25.

Out of his long experience in Illinois archaeology, Thorne Deuel has distilled a readable and comprehensive summary of the state's Indian past. The booklet is illustrated with numerous attractive drawings by Jerry Connolly, Bettye Broyles, Barbara Parmalee, and Jeanne McCarty, and with excellent halftones. The table of radiocarbon dates, the glossary, the classified bibliography, and the final chart of cultural characteristics of archae-

ological units provide useful, condensed information for quick reference.

Deuel sets up a classification of Illinois prehistory based upon three major culture patterns: the Lithic, Woodland and Mississippi. In his Lithic pattern he includes the paleo-Indian and Archaic phases, the latter of which he further subdivides into Simple, Medial, and Terminal periods. His Woodland pattern includes Initial, Advanced, Classic (Hopewellian), and Final phases. He divides the Mississippi pattern into the Middle, Upper, and Contact phases, but he mentions on page 35 an "(Old Village) cultural phase" which he also appears to designate as "Protomississippi (Protomiss)" on page 56 and as "an early subculture termed Old Village" on page 35. The historic Illini Confederacy is considered by Deuel to represent the descendants of the Middle Mississippi phase. I had some difficulty in extracting the total framework of subcultures and divisions of subcultures, since Deuel refers on page 60 to the Crab Orchard culture as a "division of the Baumer sub-culture" and on page 59 to the Archaic as a "subculture." "Subculture" he defines on page 65 as "any archaeological grouping smaller than a phase."

One might raise some questions about certain statements such as "The bow and arrow invented in the Final Woodland phase . . ." or "the Middle Mississippi phase developed through the interplay of invention and adoption of improvements, modification and re-invention, between the Final Woodland subcultures in Illinois and adjacent territory." I find it hard to conceive of a Final Woodland phase, which Deuel calls "The Dark Age in Illinois," giving birth to the "Cahokia" and "Cumberland" subcultures.

Deuel successfully conveys to the layman reader, for whom the booklet is intended, the concept of human groups interacting with each other and their environments in the building of cultures. In his reconstructions of economic, social, religious, and recreational features, based upon analogies with those of contemporary primitive peoples, he rounds out the picture of prehistoric life based upon archaeological remains. Such treatment goes far to promote understanding of and to gain support for archaeological research.

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ARCHIVES OF ARCHAEOLOGY: A NEW PUBLICATION SERIES ON MICROCARDS

DAVID A. BAERREIS AND JOHN J. SOLON

At its annual meeting, the Society for American Archaeology authorized the establishment of a new publication series making use of Microcards as the medium of publication. Since that time, a co-operative agreement has been reached with the University of Wisconsin Press to publish the series jointly, an editorial committee has been appointed, a name has been given to the series (*Archives of Archaeology*), and the first numbers are now available for distribution.

Two main considerations served as the rationale for the establishment of the new series. The first is that the continued growth of archaeology as a discipline is being impeded by inadequate publication. Despite the expansion of the field and the greatly accelerated excavation programs resulting from salvage work and river-basin programs, a comparable increase in the volume of publication cannot be seen. Obviously the factor of cost is in operation here, for an organization like our own Society is publishing as much material as its financial resources will permit. This leads, then, directly to a second consideration. Are we keeping abreast of new developments in the publication media and making the most effective use of new techniques now available? It is necessary that much important archaeological data be made available to interested scholars, but those who need the primary excavation and descriptive information pertaining to a particular site are relatively few in number. Microcard publication is adapted to a situation where the demand is limited and a relatively small edition is needed.

Microcards to some of our readers may still be relatively unfamiliar and may thus require description. Those used in our series are 75 by 125 mm. (approximately 3 by 5 inches) in size, printed on both sides. Each is printed for easy identification with a heading in type legible to the naked eye and contains on one side usually from 36 to 48 pages of typed or printed text and illustrations (6 by 9 or 8½ by 11 inches) reduced by a factor of between 1/15 and 1/20. The cameras used to copy the original text are, of course, flexible and the reduction factor can be varied considerably to suit special requirements; thus the size of the sheets of copy influences the number of pages on a single card. This feature is particularly adaptable for large maps and diagrams which can be photographed and stored in a convenient 3 by 5 file. Microcards are positive photographic prints and therefore, without the distortion of a dot pattern used to achieve a screen in other forms of printing, they can reproduce sharply anything that can be photographed. A manuscript including photographs, charts, and drawings can be filmed directly, and typesetting, engraving costs, and the like are eliminated. The cards are made on permanent heavy-gauge paper stock and will remain legible and physically intact indefinitely.

The Microcard series does not compete with already established publication series or journals, but it does provide an outlet for fully documented accounts of investigations. Beause of lower production costs, elaborate charts and tables need not be omitted. Indeed, if there is any need for it, there is no reason why a site collection should not be illustrated in its entirety or why a full series of photographs should not record the progress of a site excavation. Ideally the Microcard publication should be accompanied by a printed summary, perhaps a journal article, in which the information of more general significance obtained through the study is made available to a wider audience. Thus the Microcard publication provides the basic documentation through which the student can check the validity of the inferences drawn or find specific information needed for further comparative studies. This need not be the sole pattern. It may be preferred to issue a monograph in conventional printed media and make use of Microcards for statistical or supplemental data that would ordinarily because of the expense be condensed or relegated to an appendix. Or it may be that we shall publish on Microcards some materials which deserve broader circulation but which cannot be issued by letterpress at the present moment because of prohibitive expense.

Our editorial policy in relation to *Archives of Archaeology* is frankly exploratory. We need to discover both the limitations and potentialities of the medium for our field. Since there are no comparable series for fields closely related to archaeology, we feel that we should publish not only strictly archaeological reports but also information pertaining to physical anthropology, ethnohistory, and ethnography. Information on how Indians made pottery vessels is obviously important in the interpretation of ceramics in archaeological sites just as historic documentation is essential to the identification of an occupation at a site. Similarly, in obtaining a complete account of prehistoric life, information on the physical remains of the occupants of a site is as important as a description of the cultural remains they produced. Just as the contents of *Archives of Archaeology* may be varied, so too we need impose no arbitrary restrictions on form or format of material to be photographed. As we become more accustomed to using Microcards, we shall doubtless learn the most convenient procedures in relation to them. Now, or at a later date when the first numbers of the series become familiar through examination, the Editors of the series will greatly appreciate receiving your comments and suggestions regarding the project.

Like the editorial policy, the pricing and edition size of this new series are also in an experimental stage. Since the major objective of *Archives of Archaeology* is to provide primary documentation of archaeological investigations and related materials, it is certain that interest in a particular report will necessarily be more limited than interest in a broader study. Numbers in the series will not, therefore, be distributed to all members of the Society for American Archaeology without charge. Each must be purchased and each number will be individually priced. The Society for American Archaeology and the University of Wisconsin Press intend to make these research results available at the lowest cost possible. The price of individual numbers will depend in a large part on the length of the manuscript, but the edition size is also a factor in the pricing. Therefore as the number of purchasers of the series increases or decreases, a change in the selling price will result.

Microcarding is essentially an edition process, that is, an efficient way of producing multiple copies. Microcarding is a means of publication, not a copying method. The savings offered by Microcards are for the most part not realized unless an edition of at least fifteen copies is produced. The negatives from which Microcards are printed are preserved indefinitely in specially designed fire-resistant vaults. The negatives, of course, belong to the publisher so that no material printed on Microcards need remain out of print.

Archives of Archaeology has been printed on two-sided cards. The recent development of the two-sided card eliminates the problem of curling which has been common to all photographic prints. Sixty-five of these cards occupy one inch in a 3 by 5 filing drawer. Thus, in *Archives of Archaeology* where we print a total of 90 pages on the front and back of a card, 6000 pages can be filed in one inch of drawer space. This is the equivalent of twenty 300 page volumes.

Microcards must be read by means of a magnifier. At the present time there exist a number of excellent reading machines. Such machines are installed in every important university library and research laboratory in the United States as well as in important public libraries and technical libraries of large industrial organizations. The three most widely used readers are those manufactured by the Eastman Kodak Company, the American Optical Company, and the Microcard Corporation (Reader Division). All sell for about $300.

The Eastman Kodak Company's Microprint Reader Model A will take cards up to 8½ by 11 inches. It is 17½ inches high, 22 inches deep, and 14 inches wide. The screen of the reader is 8¾ by 10½ inches in size and is green in color. The reader magnifies 22 times. The card is inserted in a drum and can be scanned rapidly from any desired point.

The Micro Opaque Reader (A05075) manufactured by the American Optical Company will take cards up to a maximum of 9 inches square and has a screen size of 11 by 12⅝ inches. There is a choice of three lenses with this reader, 15x, 20x, or 23x. While this reader has an opaque screen, nevertheless the construction permits exposure of sensitized paper as the initial step in producing photocopies. Although copies can be produced in this manner, the results at the present time usually leave something to be desired.

The Reader Division of the Microcard Corporation manufactures three table-model readers, Model 5B, Model 6B, and Model 6B Special. These readers will take a card 6 inches in width and undetermined length as may be required. The screen size is 9⅞ by 10½ and the magnification ratio is 23x. The 5B demands that the card be moved manually while the 6B and 6B Special have positive knob-activated card-moving mechanism. The 6B Special is identical to Model 6B except that it has a 300-watt lamp and blower cooling as opposed to a 150-watt lamp without the blower cooling in the other model. The 6B Special is ideal for use in highly illuminated locations since the increased wattage provides a sharp, clear image.

In addition to the table-model readers discussed here, the Reader Division of the Microcard Corporation manufactures a pocket-size reader. Slightly larger than a package of king-size cigarettes, this reader is designed for intermittent reference and used properly is quite effective. It is not satisfactory for continuous close reading and should not be purchased for this kind of use. A pocket-size reader which makes use of two small batteries or 110-volt current is available for $25.00. Very recently a pocket reader selling for $15.00 has been developed which utilizes an ambient light source.

It is believed by many that the use of microprint cards will increase rapidly when a technique for copying individual pages in an enlarged size directly from the cards has been marketed and when more efficient and less expensive readers are available. The present stage of development, however, provides such a valuable research tool that scholars can ill afford not to take advantage of it. Research on copying methods and more efficient and inexpensive readers has progressed at a rapid pace. It is anticipated that new developments in electronics will permit advances in these areas which will keep abreast of the growing demand for material in microform. We shall attempt to describe very briefly and in general terms one or two of the developments now in progress.

Problems of technique for copying directly from Microcards have been solved, but the type or types of copying apparatus to be marketed have not yet been determined. There are at least three alternatives: first, a separate copying device of quite simple design which must be used in a darkened room and which is entirely separate from the reading machine; second, an adaptation of the present Microcard Corporation reader which would allow copies to be made by inserting a holder behind the screen and processed in a lighted room; and third, the fully automatic push-button operated reader-printer. At the present time the research staff of the Microcard Corporation Reader Division is pursuing all three of these paths of investigation in an attempt to determine which is the most desirable machine. Proto-

types of the models described above have been constructed. It is, of course, quite possible that more than one type of copying apparatus will be required to serve different markets and uses.

What may well prove to be a highly significant development in the use of microprint cards is the spectacle type of reader which has recently been designed, but not yet marketed. Since this reader is similar to eyeglasses, it frees the reader's hands for note-taking and also overcomes the problem of motion between the card and the reader's eye. An effort is now being made to develop improved lenses, although the lenses now used are satisfactory for most purposes.

It should be evident from the description of the Microcard production process as presented above that a very decided asset is its low production costs and consequent low retail price. We can now publish long manuscripts without financial subsidy from the author or his institution. All that is required is a manuscript ready to be photographed. Best results will be obtained from a ribbon copy where care has been taken to see that a fresh ribbon providing uniform black copy has been used throughout the typing process. We can promise speedy action on manuscripts. When a manuscript is received in good condition, read, and approved for publication, a period of two months should be adequate to see the study ready for distribution. For those who have manuscripts in preparation, a style sheet will be provided upon request. Manuscripts may be submitted to any of the editors:

John B. Rinaldo, Chicago Natural History Museum, Chicago 5, Illinois; Stephan F. Borhegyi, Milwaukee Public Museum, Milwaukee 3, Wisconsin; David A. Baerreis, University of Wisconsin, Madison 6, Wisconsin.

Thompson Webb, Jr., University of Wisconsin Press, and Raymond H. Thompson, both *ex-officio* members of the Editorial Committee, are also available for information and consultation. Orders for numbers in the series should be sent to the University of Wisconsin Press, 430 Sterling Court, Madison 6, Wisconsin.

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NOTES AND NEWS

EDITED BY NATHALIE F. S. WOODBURY

The Museum of Anthropology of the University of California (Berkeley) has been named the Robert H. Lowie Museum of Anthropology by official action of the Regents. Its offices are now at 103 Kroeber Hall, a new building which it shares with the Department of Anthropology, the Department of Art, and the Art-Anthropology Library.

ARCTIC

ALASKA. J. L. Giddings, Brown University, accompanied by Hans-Georg Bandi of the Bernisches Historisches Museum, returned for another season of excavation and reconnaissance at Cape Krusenstern. Close to 100 raised beach lines have now been determined, with Number 97 being counted as the latest, present-day ocean beach. The early Western Thule house discovered in 1958 is thus on beach 82, and the range between 57 and 50 is characterized by Ipiutak-related materials. The evidence suggests that Ipituak culture must have lasted for several hundred years here, but on earlier beaches, 50–42, there is check-stamped, then simple-stamped, pottery, with Norton and Choris-like flints. One of the outstanding discoveries of 1959 was made on beach 36 in a small cluster of house sites. Here, beneath sterile gravel, were found side-notched points, notched end scrapers, a large chalcedony blade, and many large "whaling" harpoon blades, also of chalcedony. These were associated with the bones of seal, whale, and birds. Giddings comments that the side-notched points are closely similar to those from the Old Copper culture, and further notes that this assemblage has none of the hallmarks of the so-called small-tool cultures. The Denbigh Flint complex occurs between Beaches 19 and 6 and again on a 200-foot high bench on the adjacent mountain side. At the 500-foot level a series of chert implements occurred so severely weathered that the material had deteriorated to a chalky substance. The broad, side-notched points in this find bear some resemblance to a type reported by Skarland from the Denali Highway.

Ivar Skarland, University of Alaska, continued his archaeological survey along the Denali Highway during the summer of 1959 and has thus added to the growing collection of early lithic material from that area. Frederic Hadleigh-West spent the month of August 1959 conducting archaeological survey and salvage at Cape Thompson under a contract between the University of Alaska and the Atomic Energy Commission. Cape Thompson is the proposed site for Project Chariot, a test in harbor construction by means of underground nuclear detonation. All sites he encountered in the area were of very recent Eskimo origin.

SOUTHAMPTON ISLAND. From the end of May to August of 1959 an international party worked on Southampton, Walrus, and Coats islands with the dual aim of testing the blood groups of the present-day Eskimos on Southampton and obtaining skeletal remains and associated cultural materials of the earlier inhabitants. The group included Bruce Chown and Marion Lewis of the Rh Laboratory at Winnipeg, W. S. Laughlin, C. S. Chard, and Charles Merbs of the University of Wisconsin, James Van Stone, University of Toronto, and Ralph Chown, Acadia College. The investigations were supported by grants from the National Institutes of Health, the University of Wisconsin, and the Rh Laboratory affiliated with the University of Manitoba. As planned, blood types and genealogies were secured for the Aivilik and Okomiut groups on Southampton, and archaeological excavations were carried out at Native Point, Prairie Point, and on Coats Island. A large skeletal collection, mostly from Native Point, was recovered. This includes approximately 59 infants and children, and there are sufficient adults of both sexes to determine the position of this population in comparison with Greenlandic, Labrador, and Alaskan series. In addition, the sex and age composition of the people who lived at Native Point can be studied in detail. Of special interest are the many vertebral anomalies and the extensive loss of teeth. It is known that these Sadlermiut became extinct in 1903, but, contrary to current belief, it is possible that starvation played a major role in their disappearance and that some of its effects may be found in the skeletons. Ethnological information collected from older Eskimos indicates that the people at Native Point began dying in the spring of 1902 and continued dying into the spring of 1903. The relation of the Native Point people to those who lived at Prairie Point, Walrus Island, and Coats Island is not certain. There are a number of differences in house construction, such as, the presence of entrance chambers in some of the Coats Island houses, which may reflect immediate circumstances or possibly stylized cultural differences. Comparative studies of burial practices and patterns of human occupancy are now under way.

UNGAVA. W. E. Taylor, National Museum of Canada, continued his reconnaissance of northwest Ungava and adjacent islands during the summer of 1959. On the northeast tip of the Nuvuk Islands, near Ivugivik, P.Q., he tested two Dorset sites which had been sampled in 1935 by Douglas Leechman, and in the Ivugivik area he discovered a small early Dorset site and three pre-Dorset sites. Only lithic materials were recovered from the latter, but they show strong affinity to types in the Sarqaq and Arctic Small Tool traditions. On the east coast of Mansel Island excavations were continued on two early Dorset sites found in 1958, and seven new sites were discovered, making a total of 13 in the nearby vicinity. Two of these were pre-Dorset stations situated on bare gravel terraces and extending for a distance of 3000 feet in one case and 6000 in the other. There were very faint signs of stone structures. Again, only lithic material was recovered, and that existed in such

profusion that a comprehensive surface collection was made only on half of the larger site. The pressure of time, and the minimal skill of Taylor's Eskimo crew precluded any attempt to excavate the visible traces of habitations. The side scrapers, end blades, and abundant burins from these two sites, as well as from the three pre-Dorset sites at Ivugivik, show marked similarities to the Sarqaq assemblage. These sites all give a considerable geographic extension to the known range of pre-Dorset occupation in the eastern Arctic, and it is not likely that they establish a margin of that range. Exactly where these components fit within the pre-Dorset chronology is not yet known.

GREENLAND. As part of the systematic topographical project being carried out by the National Museum of Denmark since 1946, Robert Petersen worked on the west coast of Greenland from June to September, 1959, and mapped 49 sites in the southern part of the Sukkertoppen district. Test excavations revealed two Dorset sites; the remainder were of neo-Eskimo origin.

After completing his duties as scientific adviser to the Danish liaison officer at Thule Air Base, Helge Larsen boarded the U. S. C. G. icebreaker "Atka" bound for east Greenland. In cooperation with American geologists of project "Groundhog," his main task was to investigate paleo-Eskimo sites in the Zackenberg and Dove Bugt areas in northeast Greenland. However, due to extremely difficult ice conditions the "Atka" was unable to penetrate so far north, and the archaeological work was limited to chance discoveries farther south. Dorset and Sarqaq cultures were discovered beneath a 19th-century house ruin at Umivik in Angmagssalik Fjord, and Sarqaq culture was also found at Cape Tobin and Cape Hope in Scoresby Sound.

DENMARK. Elmer Harp, Jr., Dartmouth College, is spending the academic year 1959–60 on arctic research, as a Fulbright Research Fellow at the National Museum in Copenhagen.

Assembled by ELMER HARP, JR.

NORTHWEST

OREGON. The University of Oregon, in cooperation with the National Park Service, continued in the summer of 1959 the research and salvage program in the John Day Dam reservoir area of the Columbia River. At least another three or four years will be required for the completion of this project. The area under investigation extends from the mouth of the John Day up that river as far as slack water will extend, and to the McNary Dam to the east, a distance of approximately 75 miles. By agreement with the University of Washington, both sides of the river are included in the area of operations.

Patterns of cultural differentiation both in time and space are beginning to emerge. L. S. Cressman prefers not to hazard a guess as to their ultimate significance at this time. It is hoped that eventually it will be possible to tie in the sequences in this area with those so effectively exposed at the Five-Mile-Rapids site some 20 miles down-river. David L. Cole has been in charge.

Thomas M. Newman completed the field work on the Tillamook part of the Oregon Coast Prehistory project of the University of Oregon and has evaluated the material in his doctoral dissertation. A rather surprising conclusion at the present time is that the occupation of the Oregon coast, at least in the northern part, appears to date from A.D. 1400 or later with a cultural manifestation which, while not distinctive, has a Northwest Coast suggestion to it. A second stage with a radiocarbon date of A.D. 1617 is clearly Coast Salish and ancestral to the Tillamook, which is shown in the final stage. All available evidence at the present time indicates that the early settlement of the northern Oregon coast was made by people moving down from the north, people possibly related to the bearers of Borden's Early Coast Salish culture.

Cressman's monograph on the important investigations in the Five-Mile-Rapids area will appear in the *Transactions of the American Philosophical Society* under the title "Culture Sequences at The Dalles, Oregon."

IDAHO. The joint Idaho State College Museum–Peabody Museum archaeological expedition to Wilson Butte Cave near Shoshone, Idaho, in 1959 produced significant results. Ruth Gruhn, who directed the excavations, obtained a long stratigraphic sequence, beginning with an association of extinct animals and stone tools. Further work at the site is planned for the summer of 1960.

WASHINGTON. Richard S. Daugherty reports that the 1959 investigations of Washington State University on the Snake River were especially productive. New and important data were obtained on burial practices, and excavations which were begun in a cave yielded cultural materials extending back at least 7000 years. The University's work in the Rocky Reach Reservoir area on the Columbia produced protohistoric or late prehistoric material from the six camp or village sites and one rockshelter which were partially excavated. The Sun Lakes area excavations concentrated on a thorough sampling of the deposits of a rockshelter.

During the 1959 summer season the University of Washington undertook two field projects under the direction of Robert E. Greengo. The first, in connection with the summer field school, continued archaeological salvage in the Priest Rapids and Wanapum reservoir areas along the middle Columbia River. The major excavation was at an occupation site 7/10 mile long on the west bank of the river 4 miles south of Vantage. C. A. Vaucher acted as field assistant. This site, 45KT8, proved to have two major cultural levels. An upper stratum, ranging up to 1.5 m. deep, was characterized by a more or less typical late middle Columbia River complex in which small stemmed and barbed projectile points are diagnostic. Another period of occupation was represented by scrapers and worked flakes deposited in the uppermost layers of a coarse gravel-boulder stratum which constitutes the present bed of the river in this vicinity. These gravels are separated from the upper

occupation stratum by a sterile bed of fine aeolian sand. Although the artifacts in the gravel are not in their original soil context, they could not have been moved far, for they show little or no evidence of rolling. These materials are obviously much older than those in the upper occupation, but since no organic remains are associated, dating will have to be based upon typological comparison and geological interpretation. A similar situation exists at 45YK5, some 15 miles downstream.

Two sites newly discovered by members of the field party were also sampled. 45KT46 is a small rockshelter in the basalt bluffs one mile west of 45KT8. Virtually complete excavation of this shelter by R. L. Emerson and R. S. Kidd yielded a number of fragments of S-twist cordage, coarse twined textile, and reed matting. Stone materials included flake scrapers and a possibly diagnostically shaped pestle. No great age is suggested for this site.

In a zone near the base of the bluffs, 45KT47 consists of a series of at least six shallow hearths (charred vegetal material and fire-cracked rocks) arranged in a circle about 75 m. in diameter. No worked stone artifacts have been found associated with these hearths in the excavations conducted thus far. Additional work is contemplated at this site in the hope of finding materials of greater comparative value. Further work was also carried out at 45YK6, a site of known Wanapum occupation.

The second project was located in the southwestern corner of the state and was under the auspices of the Washington State Parks and Recreation Commission. Site 45PC7 was excavated in August and September by a crew of University of Washington students directed by R. S. Kidd. This site, located some 20 miles north of the mouth of the Columbia on a long sand spit known as the North Beach Peninsula, is a midden rich in shell and bone. The mollusks represented appear to be mostly bay varieties, while the animal bones show a large proprotion of sea mammals. Undisturbed pockets of the site reached 1.8 m. in depth. Artifacts include abraded stone, chipped stone and barbed bone projectile points, as well as a number of other types of bone and antler tools. No historic material is associated with the site. This excavation is particularly significant because it is the first project to produce tangible results in this portion of the state.

During the month of September, C. A. Vaucher contracted with the State Parks and Recreation Commission to continue the historical archaeology project at Fort Simcoe. In this work, he had the full cooperation of his predecessor, B. Stallard, and of fellow park employees Maxine Robbins and Gertrude Stevens, who are also graduate students at the University.

The Washington Archaeological Society, which recently established a state-wide organization, has shifted the focus of its attention from the interior to the coast. Under the direction of Charles Nelson, exploratory testing and some trenching have been started at the "Fishtown Site," 45Sk3, located on a hill overlooking the delta at the mouth of the Skagit River. The site shows evidence of long and intensive occupation, the cultural deposit extending from near the surface down to bedrock. Materials recovered to date include ground slate and chipped stone artifacts, barbed bone points, composite toggling harpoon fragments, and some woodworking tools, such as adz blades and wedges.

British Columbia. During the latter part of the summer of 1959, the University of British Columbia field party in the Fraser Canyon excavated the 8150 B.P. horizon of Site DjRi 3, which had just been exposed at the time when the last "Notes and News" copy was submitted. Heavy cobble choppers and numerous irregular flake scrapers dominate the assemblage of 167 artifacts recovered from this horizon. Well-made end-, side- and spokeshave scrapers and chipped knives also occur. Projectile points are relatively rare. Two complete specimens have a single shoulder or slight inset rather high up on one side. One leaf-shaped point with a broken tip has a rounded base. Charred pits of a wild cherry, tentatively identified as *Prunus demissa*, were found throughout the early occupation level. There appears to be little cultural difference between this and the next oldest culture stratum of the site, for which K. J. McCallum, University of Saskatchewan, has just reported an age of 7350±150 years. Massive deposits of streamlaid gravel and a layer of volcanic ash, evidently from the Glacier Peak eruption, overlie this later occupation. The last eruption of this volcano has been dated at 6700 B.P. The next cultural horizon at the site is probably much more recent. Well-made ground slate knives are already present and there is a possibility that this occupation is more or less contemporary with a cultural horizon at Site DiRi 1 near Hope, in which fragments of similar knives were found next to a hearth that has just been dated by McCallum at 2270±100 B.P. Further excavations at the Fraser Canyon site are planned for the summer of 1960.

H. R. MacMillan of Vancouver has indicated his intention to lend financial assistance to the Division of Archaeology of the University of British Columbia for the next five years. Borden plans to use these funds primarily for site surveys in areas threatened by proposed power reservoirs.

Assembled by Charles E. Borden

CALIFORNIA

Norman Wilson excavated, with a permit from the U.S. Bureau of Land Management, at the Loyalton Rock Shelter, Sierra County, for the State Indian Musem in June. Assisting Wilson were L. Arthur Payen, Louis J. Payen, and David Boloyan. The several hundred projectile points recovered from the shallow site will aid in a fuller definition of the Martis and Kings Beach complexes of the central Sierran region.

Adan Treganza, of San Francisco State College, excavated this past season at the Wintu Pumping Plant site (Shasta County) under a contract with the National Park Service. The field work was under the direction of

Martin Heicksen, of Bethany College, Santa Cruz. The Wintu site, Sha-169, provided some 39 burials. Two summers' work (1957–58) in the Trinity Reservoir area by Treganza, under contract with the National Park Service and the University of California, have resulted in the report "Salvage Archaeology in the Trinity Reservoir Area, Northern California—Field Season 1958" (Reports of the University of California Archaeological Survey No. 46, May, 1959). Additional work completed by Treganza includes archaeological investigation of the Vallejo Adobe at Petaluma Adobe State Historical Monument; the examination of seven Indian shellmounds in the Tomales and Drake's Bay areas with reference to 16th century historic contacts; and the examination of two Indian shellmounds within San Francisco Bay with reference to the possible 1579 landfall of Sir Francis Drake. All work was done for the State Division of Beaches and Parks.

The University of California Archaeological Survey in Berkeley has continued to assist the National Park Service in its program of salvage archaeology. During the spring of 1959, Albert Elasser made a survey of Stumpy Meadows in El Dorado County, and in the summer surveyed three high Sierran meadow localities, Hope Valley and Pickel and Leavitt meadows in Sequoia-Kings Canyon National Parks. About 50 new sites were recorded, the majority of them apparently associated with prehistoric hunting or transmontane trade trails. In no portion of either of the parks was evidence of intensive summer occupation noted comparable to that found for the Yosemite National Park region to the north. Two sites, one in each park area, were selected as worthy of excavation in the future.

Donald Jewell, of American River Junior College, Sacramento, has published his "Archaeological Salvage Excavation of Two Sites (4 Sut 21 and Sut 22) on the Feather River levee near Nicolaus, California." This work, with the assistance of John Clemmer, was performed prior to the U.S. Corps of Army Engineers relocation of the Feather River levee north of Sacramento.

A report by Brigham Arnold and Richard Reeve, Sacramento State College, on "Archaeological Investigation in the Monticello Reservoir Area" has been accepted by the National Park Service. The report is concerned with the last of a series of archaeological excavations intended to salvage a part of the record of pre-European occupancy of Berryessa Valley, Napa County, in the Coast Range northeast of San Francisco prior to its flooding by the waters ponded by Monticello Dam. The work was done under contract between the Sacramento State College Foundation and the National Park Service.

The National Park Service has negotiated a contract with the University of California at Los Angeles, through Clement Meighan, to carry out additional salvage excavations in the Vaquero (Twitchell Dam) Reservoir area. This contract was a direct result of Marshall McKusick's report, "An Archaeological Survey Report of Vaquero Reservoir, Santa Maria Project, Santa Maria River Basin, California." The present work is under the direction of McKusick. Archaeological salvage parties from the University, also under the direction of McKusick, have excavated at El Portal in Yosemite National Park under contract with the National Park Service. A preliminary report on the work so far completed has been submitted.

The University of Southern California has been active in the field of salvage work. Under the direction of William Wallace and under contract with the National Park Service, the University completed two archaeological surveys of the Buena Vista and the Arroyo Grande Watershed Projects in San Diego County. Reports with site survey sheets were submitted for both of these areas. Roger J. Desautels and H. Robert Hammond also reported on these surveys in "Preliminary Report on an Archaeological Survey of the Arroyo Grande, California" (Archaeological Research Associates Bulletin, Vol. 3, No. 3, October, 1958) and "Archaeological Resources of the Buena Vista Creek Watershed, San Diego County, California" (ARA Bulletin, Vol. 3, No. 4, January, 1959). Wallace and his students also have completed the excavation of three sites in the Casitas Reservoir near Ventura, California, in partial fulfillment of a contract with the Park Service.

Assembled by FRANCIS A. RIDDELL

PLAINS

PLAINS CONFERENCE. The 17th Plains Conference for Archaeology took place at the University of Nebraska on November 26–28, 1959. Robert L. Stephenson was Chairman. The first session, on Thanksgiving afternoon, November 26, was chaired by Warren W. Caldwell and was devoted to reports of field work in the 1959 field season. There were 18 reports on sites ranging from Alberta and Saskatchewan to Texas. Slightly more than half the reports pertained to reservoir salvage archaeology, a considerable decrease from recent years which reflects both a drop in available salvage funds in the Plains and perhaps also a trend toward a healthier balance between salvage and nonsalvage work.

On Friday morning, November 27, a session on "Plains Culture Sequences" was chaired by Wesley R. Hurt. Brief discussions of key complexes from Nebraska to the Canadian Plains were made by Marvin F. Kivett, Richard P. Wheeler, John L. Champe, Charles H. McNutt, James H. Howard, Alfred W. Bowers, Carlyle S. Smith, Hurt, and Alice B. Kehoe. Also, Lewis R. Binford reported progress in the use of the proportional flow counter in attacking dating problems relating to relatively short periods of time. A chronological chart was drawn up as a result of the discussion.

On Friday afternoon, Donald J. Lehmer led a discussion of Plains-Southwest relationships. Formal discussants were David A. Baerreis, Robert E. Bell, Champe, Preston Holder, McNutt, Albert H. Schroeder, James B. Shaeffer, Stephenson, Fred Wendorf, and Joe Ben Wheat. On Friday evening, Hugh Cutler presented an illustrated talk on "Plains Ethnobotany."

The Saturday morning session, chaired by Holder, was a discussion of "Plains Ethnohistory: Some Recent Facts and Fallacies." Panelists were Champe, Franklin Fenenga, Lehmer, Schroeder, G. Hubert Smith, and Waldo R. Wedel. The discussion revolved mainly around the subject of Spanish and French penetration into the Plains.

Marvin F. Kivett chaired the final session, on Saturday afternoon, which was a panel discussion on "Administrative Problems in Highway Salvage." Panelists were Hurt, Shaeffer, Wendorf, Wheat, and Roscoe Wilmeth.

Wheat was elected Chairman of the 18th Plains Conference which will meet on Thanksgiving weekend, 1960, at the University of Oklahoma in Norman. Shaeffer was elected Editor of the *Plains Anthropologist*.

North Dakota. In a project mentioned briefly in the January issue, James H. Howard and John Rick worked for seven weeks in June and July at the Huff site (32 MO 11), a fortified village on the west bank of the Missouri about 26 miles south of Bismarck, in the Oahe Reservoir area. The project was sponsored by the National Park Service, the North Dakota State Historical Society, and the University of North Dakota. (There had been earlier excavation at Huff in 1938 by Thad Hecker.) Two rectangular structures in the village, and two bastions in the fortifications, were excavated. The work showed that the site was surrounded by a moat 4½ feet deep, at the inner edge of which was a *chevaux-de-frise* of stakes. Within this was the palisade, bastioned at intervals. In each bastion was some sort of watch tower, and a hearth.

Huff is unusual in that the lodges, which were apparently not earth lodges, were laid out in regular rows with wide streets between. The site dates from the "Middle Mandan" period, about A.D. 1500, when the ancestral Mandan were at the peak of their population and territory.

South Dakota. A University of South Dakota Museum–National Park Service–South Dakota Historical Commission field party under William G. Buckles excavated from September 28 to October 24 at the cemetery of the Four Bears site (39 DW 2), believed to be an Arikara village described by Lewis and Clark. Earlier work had been done at the site in 1958. Of the 42 burials excavated, 21 were adults and 21 were children and infants. Nearly all the burials were tightly flexed primary burials on the side or back, with the head north. Grave goods included both European specimens of about A.D. 1800 and items of native manufacture. George A. Agogino of the University of Wyoming will do the analysis of the skeletal material, which is of particular significance because of the high probability of its identification with a specific tribe, the Arikara.

Wyoming. In the autumn of 1958 James Duguid and Melvin McKnight, geology students at the University of Wyoming, discovered an important stratified paleo-Indian site about ¼ mile from the Agate Basin site (investigated by Frank H. H. Roberts, Jr., in 1942) in Niobrara County, eastern Wyoming. The site, called the Brewster site, contained Folsom points stratigraphically below Agate Basin points. Aided by a grant from the National Geographic Society, Agogino of the University of Wyoming worked at the site from August to the end of October, 1959, on weekends and for one ten-day period, aided by W. D. Frankforter and C. V. Haynes, Jr., as well as by students of the University of Wyoming and members of the Northwest Iowa and Wyoming Archaeological Societies.

The highest cultural stratum is a continuation of the cultural zone at the near-by Agate Basin site, and two Agate Basin points were found in it. Below were two more cultural strata, in the lower of which one Agate Basin was found. Bison bones from these three Agate Basin strata are not definitive as to species, but they do not seem to be *B. bison*. In the lowest zone at the site two classic Folsom points were found, along with two bison skulls tentatively identified as female *B. antiquus*. Charcoal for radiocarbon dating was collected from all the cultural levels.

David Gebhard of the Roswell, N. M., Museum, continued his pictograph studies in Wyoming with a few weeks' work in the summer of 1959. One cave on Bull Creek in the Wind River Mountains, has paintings dating from the 18th or 19th centuries. Another, near the Sweetwater River, has black and red paintings of a hitherto unknown style: nothing is known of the date. A third cave near Laramie has pictographs and a substantial cultural deposit. Gebhard has been working in this last site in cooperation with Agogino.

Assembled by E. Mott Davis

NORTHERN MISSISSIPPI VALLEY

Illinois. Last summer the student field expedition of the University of Illinois, under the direction of John C. Mc.Gregor, spent two months working on an historic site on the Rock River near its mouth south of Rock Island. This large village site, extending for more than a half mile along the river on a slight sand ridge, is believed to have been occupied by the Sauk from about 1790 to 1810. Previous salvage work had been done here by Elaine Bluhm and a party of students, who also continued work after the main field party had left the site. Several rectangular houses were found, at least one of which was quite long. Many refuse pits, some smaller pits containing charred corn, and a number of burials were also excavated. Most of the artifacts were trade materials, apparently largely of British or Canadian origin. Most interesting was the fact that about the only native manufactures consisted of stone pipes and articles made of bone. These Indians were smelting lead from ores and casting bullets and other objects of this metal. This has proven to be a very rich and informative site, and it is hoped that additional work can be done before the land is sold for some other purpose than the farming it is now used for.

The Illinois Archaeological Survey has employed Charles J. Bareis on full time to undertake preliminary surveys in connection with the Highway Salvage program. Funds are supplied by the State Highway Department. During September and October, he traveled almost 5000 miles, surveyed between 75 and 100 miles of right-of-way, and located 26 archaeological sites, mostly of the campsite or village type.

Following preliminary excavations of 1958, Stuart Struever, graduate anthropology student at Northwestern University, and a crew of college undergraduates excavated Mound 9 of the Kamp Mound Group, Calhoun County, during the period from late June to mid-August. Work involved the complete delineation of a stone-covered burial crypt built into a composite earth mound measuring 260 by 135 by 14 feet. In this crypt, associated with a predominance of secondary interments (bundled and scattered bones) laid in a puddled clay matrix, were artifacts typical of Illinois Hopewell. Prominent among these were four vessels of the Baehr series and associated charcoal samples which have been submitted to the University of Michigan for radiocarbon dating. Mound construction included a primary tumulus of "loaded" fill capped by a layer of homogeneous blue gumbo over which a secondary mound was built in two stages. Burial was confined entirely to the central crypt. Large quantities of redeposited village refuse were contained in the secondary mound fill, and a village site beneath the mound was also excavated. Comparison with other Hopewell mortuary complexes in the Illinois and adjacent Mississippi valleys suggest it is a late Hopewell manifestation. Additional excavations were undertaken in a relatively deep village deposit between two other mounds of this group. One notable feature of the Kamp group is the arrangement of its ten mounds in a rectangle. Excavation within this area disclosed what has been tentatively identified as a hard-packed "floor" that may be representative of a plaza or similar feature.

INDIANA. The Indiana Historical Society sponsored the fifteenth consecutive annual field school, directed by Glenn A. Black, at Angel Mounds during the summer of 1959. Students from Indiana University, University of Pittsburgh, and Baltimore Institute were represented in the enrollment. In addition to normal activities connected with the course there was, this year, an attempt made to employ geophysical instruments to archaeological problems. Relative resistivity of soils and the use of a proton magnetometer to measure possible earth magnetic anomalies of archaeological significance were the approaches used. Both media proved inconclusive and this was especially true with the magnetometer. Readers interested in the subject may write Glenn A. Black for details.

Indiana manages to keep abreast of the Highway construction program in terms of salvage with J. C. Householder of Indianapolis doing most of the work connected with the program.

Charles Faulkner made an archaeological survey of Marshall County, with results so promising that a second season must be devoted to the area in order to complete it.

IOWA. The 1959 summer session field trip of the State University of Iowa partially excavated the Wittrock site, a late Mill Creek village in northwestern Iowa. Eleven students were enrolled for credit under the direction of Reynold J. Ruppé. The village was chosen because the surface pottery was late relative to other Mill Creek sites. Excavation revealed that the village was indeed late in the Mill Creek sequence and the results of the work will give us information about the final stages of the Mill Creek manifestation. The houses are circular rather than rectangular, thus conforming to the widespread pattern of late shift of house type in the Missouri valley. Compared to earlier Mill Creek sites, the Wittrock site exhibited a shift to greater reliance of the people on hunting bison and less reliance on agriculture. Projectile points and cracked and burned bison bones are much more numerous and bison scapula hoes much less numerous at the Wittrock site when compared to earlier Mill Creek sites. The ceramic frequencies at the Wittrock site show a predominance of types which occur late in the pottery sequence as established by excavation and surface survey of other Mill Creek sites. Articles of pipestone are present but objects of European manufacture are absent. A charred support post from one of the circular houses has been submitted for carbon dating.

Principal research of Earl Ingmanson, Archeologist at Effigy Mound National Monument, has been concerned with soil development in mounds as a part of plans to rehabilitate certain mounds for display. Wayne Scholtes and Roger Parsons of the Agronomy Department of Iowa State University collected a number of soil samples from various levels in mounds and Parsons is completing the lab work to supply a morphological description of soil profiles. There appears to be a quantitative difference in soil development in mounds which are within a single group and which share a common environment. It is hoped that a technique for providing relative dates of mounds, based on the degree of development of a soil profile, may evolve. Salvage archaeology in Visitor Center construction area at the Monument produced a small rectangular house floor with a central fire pit. Square nails and glass on the floor indicate a historic date of occupation.

MICHIGAN. During July and August, George I. Quimby, Chicago Natural History Museum, made field trips to archaeological sites in Northern Michigan and some of the islands in northern Lake Michigan. Test excavations were undertaken in three sites and surface collections were obtained from five sites. The sites were picked in terms of the possibility of obtaining data on the environment and geochronology of Archaic Indians in the period from 6000 to 1500 B.C. or of obtaining information on Late Woodland peoples in the period from A.D. 1400 to 1650.

Minnesota. The University of Minnesota conducted a five-week course, directed by Elden Johnson, in archaeological field techniques at Itasca State Park during June and July. The 12 participating students excavated a Blackduck site and an earlier middle Woodland site in the Park. Survey teams also located approximately 30 additional habitation sites in the vicinity of the Park. Most interesting was the location of two large sites in Clearwater County which exhibited Mandan-like check-stamped body sherds and an S-shaped rim sherd. Both sites are adjacent to extensive wild-rice lakes in the western edge of the coniferous forest zone adjacent to the western prairie grasslands. General late prehistoric sites in the Leech Lake–Cass Lake area contained quantities of shell-tempered, cord-marked sherds of a transitional Woodland type and apparently not in association with late prehistoric Blackduck. The University hopes to conduct further field session in this area in future summers.

The latter portion of the summer was spent in a field survey of Glacial Lake Agassiz II beaches in northwestern Minnesota and eastern North Dakota. Emphasis was placed on locating preceramic sites. Approximately 110 sites were recorded. Surface finds and documented collections are now being studied to select a series of sites to be excavated in 1960–61.

Field work of the St. Paul Science Museum, supervised by Peter Jenson, was conducted at two sites. The Rooney Mound at Brooten is a natural glacial hill into which a 6-foot deep trench had been dug. A total of nine human skeletons was found during the excavation of the trench. One skull had a copper stained cheek bone and a number of leg bones had been intentionally cracked. At the Crites village site, near Stillwater, a large number of artifacts, fire places, and animal bone refuse were uncovered. Roger Nellessen, a St. Paul skin diver, found a well preserved pottery vessel 45 feet under water in Lake Phalen near St. Paul.

Wisconsin. Ronald J. Mason, Neville Public Museum, excavated the Renier site, a campsite containing projectile points resembling Eden and Scottsbluff types. A scattered cremation burial was also found. The site's location on a beach of Algonquin age near Green Bay may be a clue to dating.

Warren L. Wittry, State Historical Society, cooperating with the Wisconsin Archaeological Survey and the Oshkosh Public Museum conducted salvage operations at an historic site on Lake Butte des Morts, Winnebago County. Both aboriginal and trade artifacts were found in 100 cache pits of this stockaded village.

Robert L. Hall, Lincoln-Tallman Museum, did some salvage excavating of a Middle Woodland midden on the Rock River in Rock County. Robert J. Salzer, University of Wisconsin graduate student, worked at another Middle and Late Woodland site, also on the Rock River, in Jefferson County. These two sites provide information on the Hopewellian penetration into Wisconsin from the south.

The State Historical Society of Wisconsin has signed a cooperative agreement with the State Highway Commission to conduct highway salvage archaeology. The agreement provides for preliminary surveys and extensive testing on a reimbursement basis, and for larger excavation projects by supplemental agreement. During the summer of 1959, two men hired full-time surveyed a total of 211 miles of right-of-way on 46 federal and state projects. Twenty-seven camp or village sites and one area of extensive garden beds were found. Surface materials and results of testing are being analyzed to determine if further excavations are warranted.

Assembled by Warren L. Wittry

NORTHEAST

During the summer of 1959 a significant archaeological exploration was made of the historic arsenal site at Harpers Ferry National Monument, West Virginia, by the National Park Service. The program, under the supervision of John L. Cotter, Regional Archeologist, was carried out by the contracting archaeologist, Edward Larrabee of Columbia University. Larrabee worked for nearly two months and was able to identify and uncover the foundations of the arsenal destroyed in 1861. The excavations were completed in time for the location to be demonstrated at the 100th anniversary of the John Brown raid, October 16–17, 1959. The arsenal was the first objective of Brown and his raiders. The foundations of the Hall Rifle Works, also destroyed during the Civil War, were also located. It is expected that additional work will be continued at Harpers Ferry at the Hall Rifle Works and further exploration at the arsenal foundation area is expected to reveal rifles lost during the destruction of the arsenal buildings. Five of the famous "Harpers Ferry Rifles" have so far been found.

In May, 1958, B. Bruce Powell, Park Archeologist, Independence National Historical Park, spent two weeks at Fort Washington, Maryland, locating and exposing remains of early and mid-19th century features of that fortification. Located were: an 1842 hot-shot furnace foundation; the foundation of a circular stone tower dating to 1815 and possibly earlier; and the 1823 foundation of the Fort's flagpole. This work was accomplished as part of the development program at Fort Washington, which is a part of National Capital Parks.

At Independence National Historical Park, excavations have also been concerned with the Park's physical development. There have been excavations at the First Bank of the United States (1797); in Carpenters' Court near Carpenters' Hall; in the grounds of the Second Bank of the United States (1824); in a late 18th century brick stable; and on the east side of Congress Hall, in Independence Square, to locate the foundation remains of a portico which stood there from 1793 to 1810. The most recent excavations took place in the cellars of two tenements on Market Street at the entrance to Franklin Court, the site of Benjamin Franklin's home. The ex-

cavation, in conjunction with architectural research, proved that substantial portions of the buildings date from 1786 and were designed and constructed by Franklin himself. An intensive archaeological exploration of the site of Franklin's home is planned for next summer. In March, 1959, Jackson W. Moore, Jr., joined the staff of Independence National Historical Park after assignments at Ocmulgee and Fort Frederica National Monuments.

The National Park Service in cooperation with the Tactical Air Command experimented with aerial photography in black and white and color over Saratoga National Historical Park. The purpose was to determine whether visual identification from air views could be made of Revolutionary War redoubts and other ground works. If successful, such studies may prove useful in defining other battleground features at historic sites.

The feasibility of employing the Proton Magnetometer, developed by the Research Laboratory for Archaeology and the History of Art, Oxford, for archaeological survery work is being investigated by the National Park Service in Region 5. The instrument is designed to locate features beneath the ground which have densities variant from that of the country earth, such as walls, ditches, and holes. The Proton Magnetometer has been placed on the market for approximately $2100.

MASSACHUSETTS. Research following the excavation of the Guida Farm site near Westfield has led to the conclusion that a succession of cultural periods is represented there. These begin with Point Peninsula and end with a local focus, characterized by what is being called the Guida ware. Guida ware is one of a series of Mohawk-influenced wares recognized in New England. The other wares showing Mohawk influence are Shantok, Niantic, and Phillips. The site was excavated as a salvage operation in 1952. The work was performed by Douglas Byers, Frederick Johnson, Irving Rouse, and Kenneth Starr. A short monograph will soon be published on the work, written by Byers and Rouse.

CONNECTICUT. Bernard Powell, of the Archeological Society of Connecticut, reports an apparently unrecorded graveyard, possibly Colonial, in the Town of Stamford. The site, designated the Riverbank Site, was located following the recovery of miscellaneous human skeletal fragments by schoolboys. Several rows of field stone slabs, showing no signs of working, probably serve as head-and-foot markers. No historic records have been located which establish the origin and true nature of the site. During the Fall of 1958, Powell opened one grave. At 140 cm., a fully extended burial of an adult male was found. Hands were crossed in the pelvic region. Evidence of a wooden coffin was also recovered. H. L. Shapiro, of the American Museum of Natural History, examined the bones and identified them as those of a European Caucasoid.

Powell, who has recently assumed editorship of the Connecticut Society, adds that the Society's publishing program is being strengthened and that papers in American archaeology, especially those dealing with the Northeast, are welcome.

NEW JERSEY. The State Museum, New Jersey Department of Education, carried out a 12-week survey of the Upper Delaware River during the summer of 1959. More than 30 sites were located and mapped in the area, and material and information for a final report were collected by Charles W. Ward, working as field archaeologist for the museum. This survey was conducted under the auspices of the National Park Service.

NEW YORK. The intensive research of Father Thomas Grassmann has reached the point at which he contemplates writing a history of the Mohawk Indians. For more than 15 years, he has gathered and collated documented material dealing with these people. His research has included abstracting pertinent material in the Jesuit Relations (Thwaites edition), the Voyages of Jacques Cartier, the Works of Samuel de Champlain, the Sir William Johnson Papers and other known sources. He has also gathered early French maps, information from the Public Record Office in London, England, pertinent treaties, court records, and so on. This valuable collection of data is housed in the Mohawk-Caughnawaga Museum files, near Fonda, New York. It is probably the most complete collection of material relating to the Mohawk Indians.

The Niagara Frontier Archaeological Project carried on field work on local Iroquois sites from June through August, 1959, under the direction of Marian E. White, to study the movement of Niagara Frontier Iroquois villages. The work was aided by grants from the National Science Foundation and the New York State Museum and Science Service. During June and July, Donna V. Taylor acted as field assistant; during August, Elizabeth M. Tooker was field assistant. The field party consisted of Edward Koch and Gerald Ruth.

During June a survey was conducted along the Buffalo River and its branches to learn whether additional Iroquois villages were located between the known sites. This work was interrupted by salvage operations on the McGee site at Water Valley, Erie County. Power machinery removing topsoil uncovered the bottoms of 14 pits. This site occupies the flood plain of Eighteenmile Creek. Material from the surface and the pits indicates that this was a popular fishing area during several of the New York Indian cultural periods. The presence of Transitional Iroquois pottery in several pits, is the first evidence of this early phase of Iroquois development in the Buffalo area.

During July and August excavations were conducted on two early Historic Iroquois settlements; the Ellis site at Windom and the Simmons site at East Elma. Their place in the local chronological sequence was poorly known. A preliminary comparison with material from the rest of the sequence indicates that there were at least two contemporary Niagara Frontier Iroquois villages in the region about A.D. 1600 or somewhat earlier. Each of these was part of a separate village movement

from north to south in late Prehistoric and early Historic times.

During a seven-week period in the summer of 1959, the New York State Museum and Science Service field party, under the direction of William A. Ritchie, conducted settlement pattern studies on two large Owasco sites in central New York. Ritchie was assisted by Douglas F. Jordan and Robert Whallon, Jr., both of Harvard University, Norman F. Barka of Beloit College, and Carl S. Sundler.

Two areas, each measuring about 55 by 25 feet of the Sackett site at Canandaigua, Ontario County, were found to contain the post mold patterns of small, circular houses, 12 to 15 feet in diameter, with near center hearths, similar to those found in Ritchie's previously published excavations at this site.

At the Maxon-Derby site near Jordan, Onondaga County, under excavation for the first time, the group uncovered, in an area about 75 by 40 feet, the floor plans of a round house 16 feet in diameter; what seems to have been a rectangular structure with rounded corners about 34 by 24 feet, having a line of small hearths along one side; and a possible wall line with portions of the convex ends of a large oval building some 60 feet in length. This line of post molds traversed a portion of the rectangular structure, but the relative ages of the two could not be determined. The apparently oval house form suggested by this evidence is quite similar to an attempted reconstruction of a post mold pattern at the late Owasco Bates site excavated by Ritchie in 1958 in Chenango County, New York.

Potsherds and other artifacts from the Maxon-Derby site, on which further work will be done in 1960, indicate an early position in the known Owasco developmental series. Charcoal from the Sackett and the Maxon-Derby sites will be submitted to the University of Michigan for radiocarbon analysis.

Currently, according to Ritchie's summation, the total evidence would seem to show that several house forms were in use by Indian groups sharing the Owasco culture; that two of these, the rectangular and the oval, were communal type dwellings, which may have given rise to the multi-family longhouse of the Iroquois.

At Lewiston, the Ondiara Chapter of the Buffalo Historical Society continued its excavation of the Portage site under the direction of Richard E. McCarthy. This multi-component site contains material ranging from the Archaic through Revolutionary times. One important occupation is marked by midden debris and pits which contained pottery, large traingular points, sharks' teeth, and a cache of circular blades pertaining to a late Point Peninsula occupation. Other pottery indicates a late prehistoric Iroquois occupation. The presence of a late Point Peninsula occupation in the area raises the question of a possible ancestor for the later Iroquois development from a non-Owasco base, and one more closely related to material being recognized in the Province of Ontario.

A small field party from the Rochester Museum of Arts and Sciences conducted excavations on an early Iroquois site in the Bristol Hill region of Ontario County, New York. The site appears to be a small one and is related culturally to other early Iroquois sites in the vicinity. Current evidence suggests that this is one of the areas occupied by a group ancestral to both the Cayuga and Seneca Iroquois.

Pennsylvania. During the past year Don Dragoo, Carnegie Museum, has been gathering all available information on the Adena culture of the Upper Ohio Valley. Many private collections containing items removed from Adena mounds have been recorded and photographed. An attempt also has been made to relocate many of the Adena sites vaguely described in old references. Sufficient information has been gathered to suggest that the cultural and chronological importance of Adena is much greater than has previously been stated in the literature. A full report of the results of this project is now in preparation.

The excavation of a major historic Indian site in the Upper Ohio Valley has been undertaken by Carnegie Museum at the Chambers site at Edinburg. This site, one of four historic Kuskuski villages in the area, is being excavated by John Zakucia of the Carnegie Museum staff. Sixty-nine burials have been removed from the cemetery. European trade goods have been found associated with many of the burials and in refuse pits in the adjoining village. The information gleaned from this site will fill a vacuum formerly present in the cultural sequence of the area.

Several survey parties have been formed by the Allegheny Chapter of the Society for Pennsylvania Archaeology to aid Carnegie Museum in the recording of new sites in the Upper Ohio Valley. Nearly 200 new sites have been reported by these groups in the last year. Over 1000 sites now have been numbered in the Upper Ohio Valley.

On September 8–10, 1959, a Conference on Eastern United States Archaeology was held at the Powdermill Nature Reserve of Carnegie Museum. Present at this conference were Raymond S. Baby, Ripley P. Bullen, Douglas S. Byers, Joseph Caldwell, Joffre Coe, John Cotter, Don W. Dragoo, James B. Griffin, Alfred K. Guthe, James Kellar, Arthur R. Kelly, W. Fred Kinsey, Ben C. McCary, William J. Mayer-Oakes, Carl F. Miller, Sigfus Olafson, William A. Ritchie, Irving Rouse, James L. Swauger, Marian White, and John Witthoft. The informal nature of this conference enabled open discussion of many problems in Eastern Archaeology. Although no formal reports of this conference will be made, the many ideas exchanged there will be incorporated in future reports by the participants.

Assembled by Alfred K. Guthe

SOUTHEAST

The Weiss Reservoir salvage program on the upper Coosa River was conducted during the summer under a grant from the Alabama Power Company. The joint

Alabama Museum of Natural History–Florida State University program excavated eight sites with students from the two states. David L. DeJarnette directed three excavations on a large early historic site with at least three components: (1) an early, mostly plain, limestone-tempered pottery horizon with considerable shell midden; (2) an early historic, presumably Creek, occupation with shell-tempered ceramics somewhere between Dallas and Lamar in style; (3) an early 19th century component with Blue Leatheredge crockery and sand-tempered, simple-stamped, and cob-marked pottery. This last component is probably Cherokee. DeJarnette also excavated a small stone mound located on a site yielding only a few plain limestone-tempered sherds. During the fall excavations were begun on a large village site with quantities of steatite bowls.

The Florida State University crew excavated four sites: (1) the village site associated with the stone mound; (2) a plain limestone-tempered site with a complex palisade system consisting of a line of large, singly set posts, an interior shallow ditch, and at least two interior wall trenches; (3) a small village of the early historic Dallas-Lamar component at which several graves and a burned house were cleared; (4) a double component site of limestone-tempered period with burials overlain by the Dallas-Lamar component.

The University of Georgia began excavation of the Mandeville Mound group in the lower Chattahoochee. The work was under a River Basin Salvage contract from the National Park Service. The premound levels contained Deptford types. The mound was begun in the Early Swift Creek period; the upper layer was added during Early Mississippian times. The University also conducted salvage operations at Georgia Power Company Morgan Falls Reservoir in northern Georgia. Six rock shelters were tested. The Bull Creek near Columbus, a rather flamboyant Lamar component, was also tested. The University completed the survey and salvage in the Oliver Reservoir with excavations on 13 sites. A report has been prepared by Edward V. McMichael and James H. Kellar.

The Smithsonian Institution tested 11 sites on the lower Chattahoochee, including the village associated with the Appalachicola Fort and the early 19th century frontier town of Roanoke.

Both the University of Tennessee and the University of Kentucky conducted salvage tests in the Barkeley Basin on the Cumberland. Douglas W. Schwartz reports that a large stone box grave cemetery contained 55 graves and 77 skeletons. The grave goods are late Mississippian but included one iron trade fork. Ellis Crawford of the Behringer Memorial Museum reports that the summer work at the Gaines Mound in Boone County, Kentucky, uncovered six large elaborate Adena tombs. Work will continue next spring.

Highway salvage work in Georgia begun in May by Lewis H. Larson, Jr., is being continued under Dan F. Morse with three sites having been excavated: (1) a Mulberry Creek Plain component in northwestern Georgia related to similar sites in Alabama and Tennessee; (2) a rather mixed site in southeast Georgia with pottery and projectile points ranging from Stalling's period through Deptford to complicated stamped and cord roughened; (3) a north Georgia site begun in November. Two additional projects have already been cleared. One will involve a Civil War site at Resaca. Neitzel assisted a student dig at Etowah which discovered an elaborate burial near Mound C. The Georgia Historical Commission is proceeding with museum exhibits at Etowah and with the restoration of New Echota. The Commission Collections are now stored at Atlanta where a laboratory has been established under Phyllis Anderson.

Charles E. Snow was at the Florida State Museum during August to study skeletal material. Ripley P. Bullen and Edward M. Dolan conducted excavations at Osprey and at an Archaic or early man site on Johnson Lake, Florida. The transition from paleo-Indian levels to Archaic is still quite confused in Florida.

Historic site archaeology continued at Old Brunswick Town, North Carolina, under Stanley South. He reports a considerable series of 18th century ceramic types. Hale G. Smith and Robert Steinbach excavated a city lot for the St. Augustine Historical Society which proved to have been outside the 1700 Spanish town and contained only refuse pits. Lewis H. Larson, Jr., excavated at the site of St. Catherines Mission on St. Catherines Island off the Georgia coast. He recovered large amounts of Spanish olive jar sherds, Majolica, beads, and other Spanish artifacts dating from about 1600 to 1680. No actual remains of the mission buildings were found.

Assembled by CHARLES H. FAIRBANKS

MIDDLE AMERICA

OAXACA. Mexico City College conducted the two-weeks field portion of its annual summer quarter archaeological field methods course at the site of Caballito Blanco, near Tlacolula, first investigated the summer of 1958. With John Paddock and Charles Wicke supervising, the group of 13 students concentrated its efforts on the excavation and consolidation of the main pyramid. Two major building stages were revealed, corresponding to the Monte Albán I and II periods, plus a minor third stage. In addition, a number of burials with ceramic offerings were uncovered. A full season of excavation at this important Late Preclassic site is now planned, to begin in January, 1960.

CHIAPAS. The New World Archaeological Foundation is terminating its current program of research in the Central Depression of Chiapas. Staff members have devoted the major portion of their time during 1959 to the completion of field studies and the preparation of field reports for publication. New research was confined to termination of major stratigraphic trenches at Chiapa de Corzo and to test pitting at various related sites. The latter activity, designed to check temporal placement and regional distinctions of individual sites, has resulted in

considerable amplification of the Chiapas ceramic sequence. Consolidation of two Early Protoclassic stone-faced platform mounds at Chiapa de Corzo was also completed.

The Grijalva River reconnaissance and excavations at Chiapa de Corzo and elsewhere, under the direction of Gareth W. Lowe, have determined a comprehensive sequence of prehispanic cultural development extending from before the Preclassic up to historic times. An early occupational peak occurred throughout the Grijalva Valley at the end of the Preclassic, but the major occupation of the region is noted during the Late Classic when extensive ceremonial centers and hillside terracing were common features. This dominant nature of the Late Classic occupation concurs with observations of the University of Chicago group for the highland slopes on the north of the Grijalva.

The Grijalva survey report is in press. Other publications in preparation include: reports by Bruce Warren and Gareth Lowe on the ceramic sequence and architecture of Chiapa de Corzo; the Santa Marta preceramic phase, reconnaissance of the Río La Venta, and excavations at Mirador by Frederick A. Peterson; reconnaissance in the Frailesca region and the Chiapanecan occupation by Carlos Navarette; excavations and reconnaissance in the Isthmus of Tehuantepec region and the architecture of Santa Rosa by Agustín Delgado; and the ceramics of Santa Rosa by Lolita and Donald Brockington.

In July, 1959, Frederick A. Peterson succeeded Gareth Lowe as field director. The former and J. Alden Mason, publications director, are presently directing the work of publication of the researches of the Foundation of the past five years.

William Sanders, now at Pennsylvania State College, continues his analysis of the ceramics from the Santa Cruz site in Chiapas and the Tierra Nueva site in Tabasco. Both sites were investigated by Sanders for the N. W. A. F., the former in 1958 and the latter in 1953. Sanders has noted an interesting correspondence between certain pottery types found at the inland and coastal sites and observes a similar correspondence at Palenque on the Late Classic level.

A preceramic complex was isolated in a Central Chiapas shelter cave in the Piedra Parada zone near Ocozocoautla by Richard S. MacNeish of the National Museum of Canada (preliminarily reported upon in *American Antiquity*, October, 1959). The month-long Santa Marta Shelter investigation utilized N. W. A. F. facilities with Frederick Peterson serving as associate archaeologist. The Santa Marta lithic phase underlies stratigraphically a ceramic complex relatable to the earliest pottery phase identified at Chiapa de Corzo and is thought by MacNeish to date back to a change from dry to humid climate occurring in the third millennium B.C. Corncobs and other vegetable materials from the early levels have been submitted for analysis, as have numerous charcoal samples.

YUCATÁN. A National Geographic Society–Middle American Research Institute, Tulane University, expedition, directed by E. Wyllys Andrews, has completed three seasons' excavation at Dzibilchaltún, 10 miles north of Mérida. Possibly the largest lowland Maya site, with remains densely distributed over an area of approximately 50 square kilometers, Dzibilchaltún is further remarkable for the apparent continuity of occupation from early Preclassic to modern times. Excavations so far have been concentrated on the remains dating from late Classic to post-Conquest times. A detailed, uninterrupted ceramic-architectural stratigraphic record has been obtained for this long time span, and a preliminary notion has been gained of the radically changing settlement patterns which characterized the various phases. A large buried pyramid, Structure I, the "Temple of the Seven Dolls," which dates from the beginning of this sequence (A.D. 475 ± 140 by two radiocarbon tests on a well-preserved lintel — also established as coeval with Tepeu I of the Uaxactún sequence by ceramic tradewares), has been completely excavated and restored. Two other structures, XIV and LVII, which fall later in the Classic (Tepeu II), have received similar treatment. A number of excavations were undertaken in the "Palace Group," a massive quadrangle of buildings just south of the main plaza, with more than 100 rooms in its component structures, which revealed a clear transitional architectural phase (probably coeval with Tepeu III) between the earlier Classic tradition and the later Puuc-style phases.

Aside from these and other excavations, a detailed map of the entire archaeological zone is being prepared by George Stuart. A group of skin divers has also conducted underwater archaeological investigations during the three seasons in a deep cenote in the central ceremonial plaza. Over 30,000 ceramic fragments and other artifacts have been recovered, including a large number of whole pottery vessels and rare artifacts of wood. Alfredo Barrera Vásquez has intensively studied the Conquest period and colonial documentary sources in an attempt to pin down references to this vast site in the native historical traditions. William E. and Elizabeth Friedman, scientific cryptographers, have spent portions of two seasons in Mérida, assisted by Barrera Vásquez, studying the Maya language preparatory to an attack on the interpretation of Maya hieroglyphic writing utilizing the analytic techniques devised by scientific cryptographers during and since World War II.

Work is still progressing and conclusions are tentative, but Andrews and his associates have worked out a fundamental sequential series of periods, separated by transitional phases: *Formative*; *Early* (= Classic or Initial Series), with two sequent phases; *Florescent*, with two phases: Pure (= Puuc) and Modified (= Toltec Chichén Itzá); and *Decadent*, with two phases (= Mayapán and post-Mayapán). The sequence appears to span the period: 7.10.0.0.0–12.0.0.0.0 (GMT) or 8.5.0.0.0–12.10.0.0.0 (Spinden). Perhaps the single most significant result of the Dzibilchaltún project with regard to current ideas concerning the lowland Maya sequence is the evidence that the start of the Puuc-style Florescent Period occurred *after* the abandonment of the Central Area ceremonial

centers (post-Tepeu III or post-10.5.0.0.0). Also of great importance has been the establishment of a Black-on-Cream ceramic tradition in the transitional phase between the Modified Florescent (Toltec) period and the first phase (Mayapán) of the Decadent period. Andrews has suggested that Dzibilchaltún itself may have been the major political power in northern Yucatán during this hiatus between the collapse of Toltec Chichén Itzá and the rise of Mayapán. The work at Dzibilchaltún is also directly relevant to the now more confused than ever Maya correlation problem. After careful consideration of the results of his excavations to date, Andrews feels that the scheme that is emerging from his Dzibilchaltún project appears to square better with the 12.9.0.0.0 correlation than with the 11.16.0.0.0, although the evidence is far from conclusive.

In addition to the current season, now in progress, two more seasons of work at Dzibilchaltún are planned. Major emphasis will be placed on extending the stratigraphic sequence back through time, through the first phase of the Early period, as far back into the Formative, or Preclassic, as the evidence permits. Already the latter indicates that at least three major pre–Early period phases can be delimited.

Assembled by H. B. NICHOLSON

PLAINS ANTHROPOLOGIST

The *Plains Anthropologist*, journal of the Plains Conference has resumed publication with issue Number 9. The journal issued quarterly will be devoted to publication of research related to the Plains region. Papers are solicited in archaeological and other anthropological activities in the Plains area proper, relevant areas bordering the Plains, and field methods and laboratory techniques developed in or applicable to the Plains region. Address all communications to: James B. Schaeffer, Editor, *Plains Anthropologist*, University of Oklahoma, Norman, Oklahoma.

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